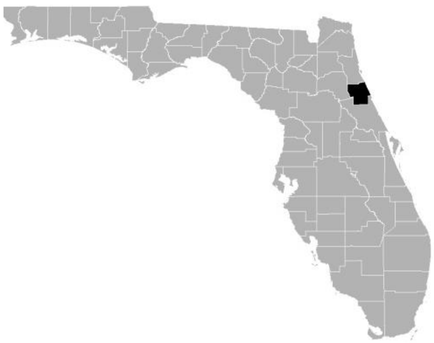
FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 3



FLAGLER COUNTY, FLORIDA

AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
BEVERLY BEACH, TOWN OF	120569
BUNNELL, CITY OF	120086
FLAGLER BEACH, CITY OF	120087
FLAGLER COUNTY UNINCORPORATED AREAS	120085
MARINELAND, TOWN OF	120570
PALM COAST, CITY OF	120684

FEMA

PRELIMINARY
03/15/2016

REVISED:

FLOOD INSURANCE STUDY NUMBER
12035CV001B

Version Number 2.3.3.2

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FLOOD INSURANCE STUDY REPORT
FLAGLER COUNTY, FLORIDA

SECTION 1.0 – INTRODUCTION

1.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a voluntary Federal program that enables property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, sea-walls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA), which is a component of the Department of Homeland Security (DHS).

Participation in the NFIP is based on an agreement between local communities and the Federal Government. If a community adopts and enforces floodplain management regulations to reduce future flood risks to new construction and substantially improved structures in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The community's floodplain management regulations must meet or exceed criteria established in accordance with Title 44 Code of Federal Regulations (CFR) Part 60.3, *Criteria for Land Management and Use*.

SFHAs are delineated on the community's Flood Insurance Rate Maps (FIRMs). Under the NFIP, buildings that were built before the flood hazard was identified on the community's FIRMs are generally referred to as "Pre-FIRM" buildings. When the NFIP was created, the U.S. Congress recognized that insurance for Pre-FIRM buildings would be prohibitively expensive if the premiums were not subsidized by the Federal Government. Congress also recognized that most of these floodprone buildings were built by individuals who did not have sufficient knowledge of the flood hazard to make informed decisions. The NFIP requires that full actuarial rates reflecting the complete flood risk be charged on all buildings constructed or substantially improved on or after the effective date of the initial FIRM for the community or after December 31, 1974, whichever is later. These buildings are generally referred to as “Post-FIRM” buildings.

1.2 Purpose of this Flood Insurance Study Report

This Flood Insurance Study (FIS) Report revises and updates information on the existence and severity of flood hazards for the study area. The studies described in this report developed flood hazard data that will be used to establish actuarial flood insurance rates and to assist communities in efforts to implement sound floodplain management.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive than the minimum Federal requirements. Contact your State NFIP Coordinator to ensure that any higher State standards are included in the community’s regulations.

1.3 Jurisdictions Included in the Flood Insurance Study Project

This FIS Report covers the entire geographic area of Flagler County, Florida.

The jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the 8-digit Hydrologic Unit Codes (HUC-8) sub-basins affecting each, are shown in Table 1. The Flood Insurance Rate Map (FIRM) panel numbers that affect each community are listed. If the flood hazard data for the community is not included in this FIS Report, the location of that data is identified.

Table 1: Listing of NFIP Jurisdictions

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Beverly Beach, Town of	120569	03080201	12035C0144E	
Bunnell, City of	120086	03080103 03080201	12035C0060E 12035C0070E 12035C0080E 12035C0085E 12035C0090E 12035C0095E 12035C0120E 12035C0180E 12035C0185E 12035C0205E 12035C0207E 12035C0209E 12035C0210E 12035C0215E 12035C0220E 12035C0226E 12035C0228E 12035C0240E	

Table 1: Listing of NFIP Jurisdictions, continued

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Bunnell, City of (continued)	120086	03080103 03080201	12035C0245E 12035C0305E 12035C0310E 12035C0315E 12035C0320E 12035C0330E 12035C0335E 12035C0340E	
Flagler Beach, City of	120087	03080201	12035C0144E 12035C0232E 12035C0234E 12035C0251E 12035C0253E 12035C0261E	
Flagler County, Unincorporated Areas	120085	03080103 03080201	12035C0015E 12035C0017E 12035C0018E 12035C0019E 12035C0036E 12035C0037E 12035C0038E 12035C0039E 12035C0060E 12035C0070E 12035C0080E 12035C0085E 12035C0090E 12035C0095E 12035C0105E 12035C0110E 12035C0115E 12035C0120E 12035C0126E 12035C0127E 12035C0129E 12035C0131E 12035C0133E 12035C0141E	

Table 1: Listing of NFIP Jurisdictions, continued

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Flagler County, Unincorporated Areas (continued)	120085	03080103 03080201	12035C0142E 12035C0143E 12035C0144E 12035C0160E[1] 12035C0180E 12035C0185E 12035C0190E 12035C0195E 12035C0205E 12035C0207E 12035C0209E 12035C0210E 12035C0215E 12035C0220E 12035C0226E 12035C0228E 12035C0230E 12035C0231E 12035C0232E 12035C0233E 12035C0234E 12035C0240E 12035C0242E 12035C0245E 12035C0253E 12035C0261E 12035C0285E 12035C0295E 12035C0305E 12035C0310E 12035C0315E 12035C0320E 12035C0330E 12035C0335E 12035C0340E 12035C0345E	
Marineland, Town of	120570	03080201	12035C0028E 12035C0036E 12035C0037E	

Table 1: Listing of NFIP Jurisdictions, continued

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Palm Coast, City of	120684	03080103 03080201	12035C0015E 12035C0018E 12035C0019E 12035C0038E 12035C0105E 12035C0110E 12035C0115E 12035C0120E 12035C0126E 12035C0127E 12035C0128E 12035C0129E 12035C0133E 12035C0136E 12035C0137E 12035C0138E[1] 12035C0139E 12035C0141E 12035C0143E 12035C0207E 12035C0210E 12035C0226E 12035C0228E 12035C0230E 12035C0231E 12035C0232E 12035C0233E 12035C0240E 12035C0245E	

[1] Panel Not Printed

1.4 Considerations for using this Flood Insurance Study Report

The NFIP encourages State and local governments to implement sound floodplain management programs. To assist in this endeavor, each FIS Report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent annual chance flood elevations (the 1% annual chance flood elevation is also referred to as the Base Flood Elevation (BFE)); delineations of the 1% annual chance and 0.2% annual chance floodplains; and 1% annual chance floodway. This information is presented on the FIRM and/or in many components of the FIS Report, including Flood Profiles, Floodway Data tables, Summary of Non-Coastal Stillwater Elevations tables, and Coastal Transect Parameters tables (not all components may be provided for a specific FIS).

This section presents important considerations for using the information contained in this FIS Report and the FIRM, including changes in format and content. Figures 1, 2, and 3 present information that applies to using the FIRM with the FIS Report.

- Part or all of this FIS Report may be revised and republished at any time. In addition, part of this FIS Report may be revised by a Letter of Map Revision (LOMR), which does not involve republication or redistribution of the FIS Report. Refer to Section 6.5 of this FIS Report for information about the process to revise the FIS Report and/or FIRM.

  It is, therefore, the responsibility of the user to consult with community officials by contacting the community repository to obtain the most current FIS Report components. Communities participating in the NFIP have established repositories of flood hazard data for floodplain management and flood insurance purposes. Community map repository addresses are provided in Table 31, "Map Repositories," within this FIS Report.

- New FIS Reports are frequently developed for multiple communities, such as entire counties. A countywide FIS Report incorporates previous FIS Reports for individual communities and the unincorporated area of the county (if not jurisdictional) into a single document and supersedes those documents for the purposes of the NFIP.

  The initial Countywide FIS Report for Flagler County became effective on July 17, 2006. Refer to Table 28 for information about subsequent revisions to the FIRMs.

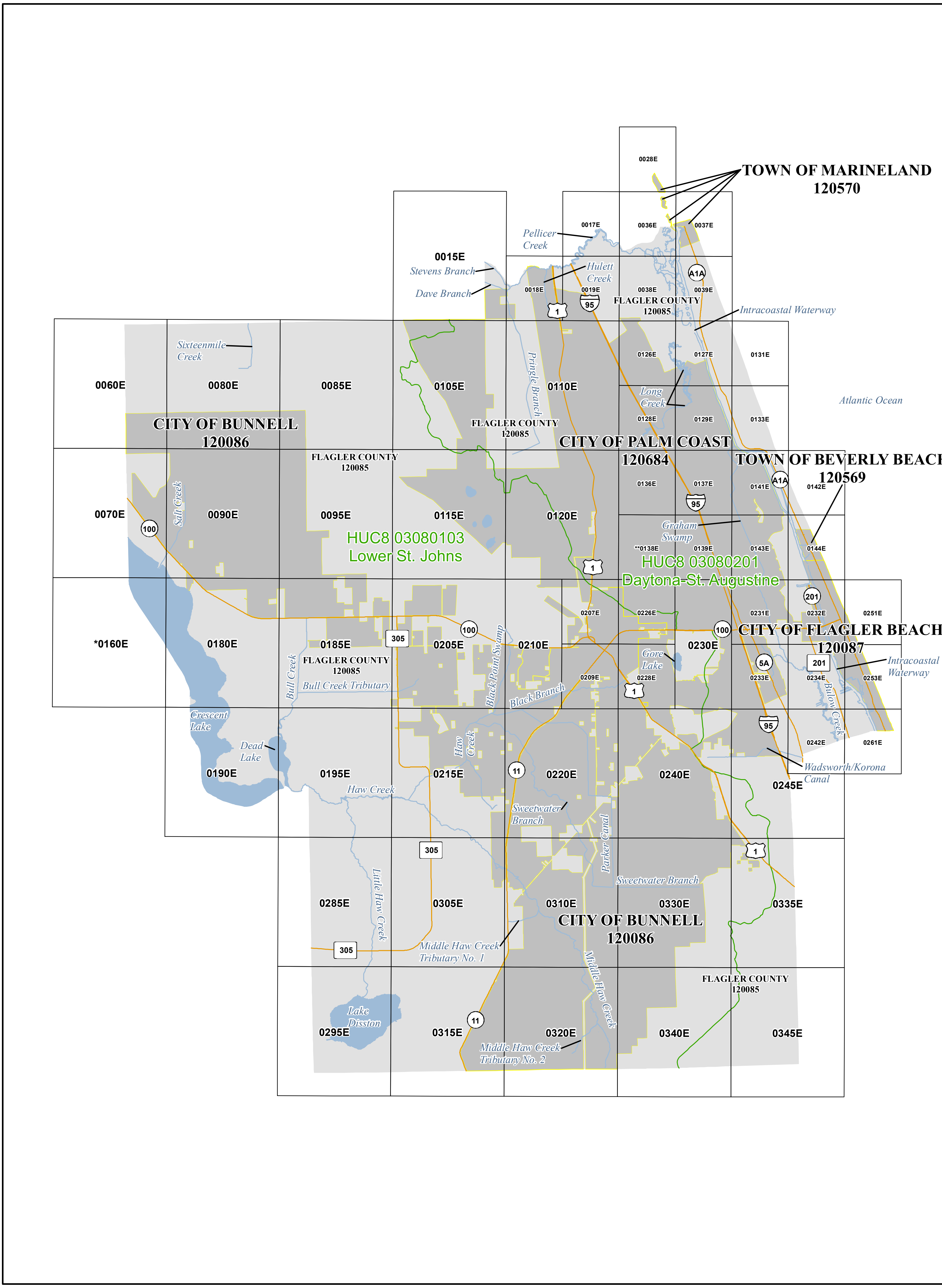
- Selected FIRM panels for the community may contain information (such as floodways and cross sections) that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels. In addition, former flood hazard zone designations have been changed as follows:

Old Zone	New Zone
A1 through A30	AE
V1 through V30	VE
B	X (shaded)
C	X (unshaded)

- FEMA has developed a *Guide to Flood Maps* (FEMA 258) and online tutorials to assist users in accessing the information contained on the FIRM. These include how to read panels and step-by-step instructions to obtain specific information. To obtain this guide and other assistance in using the FIRM, visit the FEMA Web site at www.fema.gov/online-tutorials.

The FIRM Index in Figure 1 shows the overall FIRM panel layout within Flagler County, and also displays the panel number and effective date for each FIRM panel in the county. Other information shown on the FIRM Index includes community boundaries, flooding sources, and United States Geological Survey (USGS) Hydrologic Unit Code – 8 (HUC-8) codes.

Figure 1: FIRM Panel Index



1 inch = 16,667 feet 1:200,000

0 4,750 9,500 19,000 28,500 38,000 feet

N

Map Projection:
State Plane Transverse Mercator, Florida East;
North American Datum 1983

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

* PANEL NOT PRINTED - AREA ALL WITHIN ZONE AE (EL 6)
** PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS

COUNTY LOCATOR

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

FLAGLER COUNTY, FLORIDA and Incorporated Areas

PANELS PRINTED:

0015, 0017, 0018, 0019, 0028, 0036, 0037, 0038, 0039, 0060, 0070, 0080, 0085, 0090, 0095, 0105, 0110, 0115, 0120, 0126, 0127, 0128, 0129, 0131, 0133, 0136, 0137, 0139, 0141, 0142, 0143, 0144, 0180, 0185, 0190, 0195, 0205, 0207, 0209, 0210, 0215, 0220, 0226, 0228, 0230, 0231, 0232, 0233, 0234, 0240, 0242, 0245, 0251, 0253, 0261, 0285, 0295, 0305, 0310, 0315, 0320, 0330, 0335, 0340, 0345

U.S. DEPARTMENT OF HOMELAND SECURITY

FEMA

PRELIMINARY

MAP NUMBER

12035CINDOB

MAP REVISED

Each FIRM panel may contain specific notes to the user that provide additional information regarding the flood hazard data shown on that map. However, the FIRM panel does not contain enough space to show all the notes that may be relevant in helping to better understand the information on the panel. Figure 2 contains the full list of these notes.

Figure 2: FIRM Notes to Users

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Flood Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to Table 28 in this FIS Report.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

PRELIMINARY FIS REPORT: FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period, at the final Consultation Coordination Officer's meeting, or during the statutory 90-day appeal period. Approved requests for changes will be shown on the final printed FIRM.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Non-Coastal Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

Coastal Base Flood Elevations shown on the map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Coastal flood elevations are also provided in the Coastal Transect Parameters table in the FIS Report for this jurisdiction. Elevations shown in the Coastal Transect Parameters table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIRM.

Figure 2. FIRM Notes to Users

FLOODWAY INFORMATION: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.

FLOOD CONTROL STRUCTURE INFORMATION: Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 4.3 "Non-Levee Flood Protection Measures" of this FIS Report for information on flood control structures for this jurisdiction.

PROJECTION INFORMATION: The projection used in the preparation of the map was Universal Transverse Mercator (UTM) Florida East Zone. The horizontal datum was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

ELEVATION DATUM: Flood elevations on the FIRM are referenced to the North American Vertical Datum of 1988**.** These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988**,** visit the National Geodetic Survey website at www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

Local vertical monuments may have been used to create the map. To obtain current monument information, please contact the appropriate local community listed in Table 31 of this FIS Report.

BASE MAP INFORMATION: Base map information shown on the FIRM was provided in digital format by the Flagler County GIS Department, the U.S. Census Bureau, the U.S. Fish and Wildlife Service, the Florida Resources and Environmental Analysis Center, the U.S. Department of Agriculture Farm Service Agency, and FEMA. For information about base maps, refer to Section 6.2 “Base Map” in this FIS Report.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Figure 2. FIRM Notes to Users

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Flagler County, Florida, corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 28 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.

SPECIAL NOTES FOR SPECIFIC FIRM PANELS

This Notes to Users section was created specifically for Flagler County, Florida**,** effective <date>.

COASTAL BARRIER RESOURCES SYSTEM (CBRS): This map includes approximate boundaries of the CBRS for informational purposes only. Flood insurance is not available within CBRS areas for structures that are newly built or substantially improved on or after the date(s) indicated on the map. For more information see www.fws.gov/cbra/, the FIS Report, or call the U.S. Fish and Wildlife Service Customer Service Center at 1-800-344-WILD.

FLOOD RISK REPORT: A Flood Risk Report (FRR) may be available for many of the flooding sources and communities referenced in this FIS Report. The FRR is provided to increase public awareness of flood risk by helping communities identify the areas within their jurisdictions that have the greatest risks. Although non-regulatory, the information provided within the FRR can assist communities in assessing and evaluating mitigation opportunities to reduce these risks. It can also be used by communities developing or updating flood risk mitigation plans. These plans allow communities to identify and evaluate opportunities to reduce potential loss of life and property. However, the FRR is not intended to be the final authoritative source of all flood risk data for a project area; rather, it should be used with other data sources to paint a comprehensive picture of flood risk.

Each FIRM panel contains an abbreviated legend for the features shown on the maps. However, the FIRM panel does not contain enough space to show the legend for all map features. Figure 3 shows the full legend of all map features. Note that not all of these features may appear on the FIRM panels in Flagler County.

Figure 3: Map Legend for FIRM

SPECIAL FLOOD HAZARD AREAS: *The 1% annual chance flood, also known as the base flood or 100-year flood, has a 1% chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1% annual chance flood. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. See note for specific types. If the floodway is too narrow to be shown, a note is shown.*

	Special Flood Hazard Areas subject to inundation by the 1% annual chance flood (Zones A, AE, AH, AO, AR, A99, V and VE)
Zone A	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone.
Zone AE	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone.
Zone AH	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone.
Zone AO	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the hydraulic analyses are shown within this zone.
Zone AR	The flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
Zone A99	The flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or flood depths are shown within this zone.
Zone V	The flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this zone.
Zone VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone.

Figure 3: Map Legend for FIRM

	Regulatory Floodway determined in Zone AE.
OTHER AREAS OF FLOOD HAZARD	
	Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.
	Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone.
	Area with Reduced Flood Risk due to Levee: Areas where an accredited levee, dike, or other flood control structure has reduced the flood risk from the 1% annual chance flood.
OTHER AREAS	
	Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.
NO SCREEN	Unshaded Zone X: Areas of minimal flood hazard.
FLOOD HAZARD AND OTHER BOUNDARY LINES	
(ortho) (vector)	Flood Zone Boundary (white line on ortho-photography-based mapping; gray line on vector-based mapping)
	Limit of Study
	Jurisdiction Boundary
	Limit of Moderate Wave Action (LiMWA): Indicates the inland limit of the area affected by waves greater than 1.5 feet
GENERAL STRUCTURES	
Aqueduct Channel Culvert Storm Sewer	Channel, Culvert, Aqueduct, or Storm Sewer
Dam Jetty Weir	Dam, Jetty, Weir
	Levee, Dike, or Floodwall
Bridge	Bridge

Figure 3: Map Legend for FIRM

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AND OTHERWISE PROTECTED AREAS (OPA): *CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. See Notes to Users for important information.*

CBRS AREA 09/30/2009	Coastal Barrier Resources System Area: Labels are shown to clarify where this area shares a boundary with an incorporated area or overlaps with the floodway.
OTHERWISE PROTECTED AREA 09/30/2009	Otherwise Protected Area
REFERENCE MARKERS	
22.0	River mile Markers
CROSS SECTION & TRANSECT INFORMATION	
B 20.2	Lettered Cross Section with Regulatory Water Surface Elevation (BFE)
5280 21.1	Numbered Cross Section with Regulatory Water Surface Elevation (BFE)
17.5	Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)
8	Coastal Transect
	Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation.
	Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping.
513	Base Flood Elevation Line
ZONE AE (EL 16)	Static Base Flood Elevation value (shown under zone label)
ZONE AO (DEPTH 2)	Zone designation with Depth
ZONE AO (DEPTH 2) (VEL 15 FPS)	Zone designation with Depth and Velocity

Figure 3: Map Legend for FIRM

BASE MAP FEATURES	
Missouri Creek	River, Stream or Other Hydrographic Feature
234	Interstate Highway
234	U.S. Highway
234	State Highway
234	County Highway
MAPLE LANE	Street, Road, Avenue Name, or Private Drive if shown on Flood Profile
RAILROAD	Railroad
	Horizontal Reference Grid Line
	Horizontal Reference Grid Ticks
+	Secondary Grid Crosshairs
Land Grant	Name of Land Grant
7	Section Number
R. 43 W. T. 22 N.	Range, Township Number
^{42}76^{000m}E	Horizontal Reference Grid Coordinates (UTM)
365000 FT	Horizontal Reference Grid Coordinates (State Plane)
80° 16’ 52.5”	Corner Coordinates (Latitude, Longitude)

SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS

2.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1% annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2% annual chance (500-year) flood is employed to indicate additional areas of flood hazard in the community.

Each flooding source included in the project scope has been studied and mapped using professional engineering and mapping methodologies that were agreed upon by FEMA and Flagler County as appropriate to the risk level. Flood risk is evaluated based on factors such as known flood hazards and projected impact on the built environment. Engineering analyses were performed for each studied flooding source to calculate its 1% annual chance flood elevations; elevations corresponding to other floods (e.g. 10-, 4-, 2-, 0.2-percent annual chance, etc.) may have also been computed for certain flooding sources. Engineering models and methods are described in detail in Section 5.0 of this FIS Report. The modeled elevations at cross sections were used to delineate the floodplain boundaries on the FIRM; between cross sections, the boundaries were interpolated using elevation data from various sources. More information on specific mapping methods is provided in Section 6.0 of this FIS Report.

Depending on the accuracy of available topographic data (Table 23), study methodologies employed (Section 5.0), and flood risk, certain flooding sources may be mapped to show both the 1% and 0.2% annual chance floodplain boundaries, regulatory water surface elevations (BFEs), and/or a regulatory floodway. Similarly, other flooding sources may be mapped to show only the 1% annual chance floodplain boundary on the FIRM, without published water surface elevations. In cases where the 1% and 0.2% annual chance floodplain boundaries are close together, only the 1% annual chance floodplain boundary is shown on the FIRM. Figure 3, “Map Legend for FIRM”, describes the flood zones that are used on the FIRMs to account for the varying levels of flood risk that exist along flooding sources within the project area. Table 2 and Table 3 indicate the flood zone designations for each flooding source and each community within Flagler County, Florida, respectively.

Table 2, “Flooding Sources Included in this FIS Report,” lists each flooding source, including its study limits, affected communities, mapped zone on the FIRM, and the completion date of its engineering analysis from which the flood elevations on the FIRM and in the FIS Report were derived. Descriptions and dates for the latest hydrologic and hydraulic analyses of the flooding sources are shown in Table 13. Floodplain boundaries for these flooding sources are shown on the FIRM (published separately) using the symbology described in Figure 3. On the map, the 1% annual chance floodplain corresponds to the SFHAs. The 0.2% annual chance floodplain shows areas that, although out of the regulatory floodplain, are still subject to flood hazards.

Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data. The procedures to remove these areas from the SFHA are described in Section 6.5 of this FIS Report.

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Atlantic Ocean	Beverly Beach, Town of; Flagler Beach, City of; Flagler County, Unincorporated Areas; Marineland, City of	Entire Coastline	Entire Coastline	03080201	18.0		N	VE	2015
Big Mulberry Branch	Palm Coast, City of	Confluence with Intracoastal Waterway	Approximately 1,584 feet upstream of Palm Harbor Parkway	03080201	0.6		Y	AE	2015
Big Mulberry Branch	Palm Coast, City of	Approximately 1,584 feet upstream of Palm Harbor Parkway	Approximately 0.7 miles upstream of Belle Terre Parkway	03080201	2.9		Y	AE	2001
Black Branch	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Haw Creek	Approximately 0.75 miles upstream of Old Haw Creek Road	03080103	4.2		Y	AE	2001
Black Branch	Bunnell, City of	Approximately 0.75 miles upstream of Old Haw Creek Road	Approximately 1.1 miles upstream of Old Haw Creek Road	03080103	0.3		N	A	*
Black Point Swamp	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Haw Creek	State Road 302/100	03080103	2.2		Y	AE	2001
Black Point Swamp	Flagler County, Unincorporated Areas	State Road 302/100	Approximately 1,863 feet upstream of State Road 302/100	03080103	0.3		N	A	*
Bull Creek	Flagler County, Unincorporated Areas	Confluence with Crescent Lake	Approximately 1,400 feet downstream of confluence of Bull Creek Tributary	03080103	3.5		N	AE	2001

Table 2: Flooding Sources Included in this FIS Report, continued

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Bull Creek	Bunnell, City of; Flagler County, Unincorporated Areas	Approximately 1,400 feet downstream of confluence of Bull Creek Tributary	Approximately 70 feet upstream of State Route 100	03080103	2.9		Y	AE	2001
Bull Creek Tributary	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Bull Creek	Approximately 28 feet upstream of County Route 305	03080103	3.3		Y	AE	2001
Bulow Creek	Flagler County, Unincorporated Areas	Flagler/Volusia County boundary	Approximately 4.9 miles upstream of Flagler/Volusia County boundary	03080201	4.9		Y	AE	2015
Bulow Creek	Flagler County, Unincorporated Areas; Palm Coast, City of	Approximately 4.9 miles upstream of Flagler/Volusia County boundary	Approximately 5.2 miles upstream of Flagler/Volusia County boundary	03080201	0.3		Y	AE	2006
Bulow Creek	Flagler County, Unincorporated Areas; Palm Coast, City of	Approximately 5.2 miles upstream of Flagler/Volusia County boundary	Approximately 75 feet upstream of Old Kings Road	03080201	1.1		Y	AE	2001
Bulow Creek Tributary	Palm Coast, City of	Confluence with Bulow Creek	Approximately 0.89 miles upstream of confluence with Bulow Creek	03080201	0.9		Y	AE	2001
Bulow Creek Tributary	Palm Coast, City of	Approximately 0.89 miles upstream of confluence with Bulow Creek	Approximately 0.93 miles upstream of confluence with Bulow Creek	03080201	0.04		N	A	*

Table 2: Flooding Sources Included in this FIS Report, continued

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Crescent Lake	Flagler County, Unincorporated Areas	County boundary	Confluence of Haw Creek	03080103	16.3		N	AE	*
Dave Branch	Flagler County, Unincorporated Areas; Palm Coast, City of	Confluence with Crescent Lake	Approximately 4,270 feet upstream of confluence with Pringle Branch	03080201	0.8		N	A	*
Dead Lake	Flagler County, Unincorporated Areas	Confluence with Crescent Lake	Confluence with Bull Creek	03080103		0.6	N	AE	2015
Fox Cut Waterway	Flagler County, Unincorporated Areas	Convergence with Intracoastal Waterway	Convergence from Intracoastal Waterway	03080201	2.9		N	AE	2015
Gore Lake	Flagler County, Unincorporated Areas	Approximately 1,840 feet upstream of Laguna Forest Trail	Approximately 5,200 feet upstream of Laguna Forest Trail	03080103		0.1	N	A	*
Graham Swamp	Palm Coast, City of	Confluence with Intracoastal Waterway	Approximately 0.7 miles upstream of Colbert Lane	03080201	1.7		N	AE	2015
Graham Swamp	Flagler County, Unincorporated Areas; Palm Coast, City of	Approximately 0.7 miles upstream of Colbert Lane	Approximately 4.2 miles upstream of Colbert Lane	03080201	3.3		N	AE	2001
Haw Creek	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Crescent Lake	Confluence of Black Point Swamp and Black Branch	03080103	9.8		Y	AE	2001
Hulett Branch	Palm Coast, City of	Confluence with Pellicer Creek	Approximately 1.3 miles upstream of confluence with Pellicer Creek	03080201	1.3		N	A, AE	*

Table 2: Flooding Sources Included in this FIS Report, continued

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Intracoastal Waterway	Beverly Beach, Town of; Flagler Beach, City of: Flagler County, Unincorporated Areas; Marineland, Town of; Palm Coast, City of	County boundary with Volusia County	County boundary with St. Johns County	03080201	18.5		N	AE	2015
Lake Disston	Flagler County, Unincorporated Areas	Confluence with Little Haw Creek	Approximately 1.5 miles upstream of confluence with Little Haw Creek	03080103		2.9	N	A	*
Lambert Cove	Flagler Beach, City of; Flagler County, Unincorporated Areas	Confluence with Intracoastal Waterway	Approximately 2,330 feet upstream of confluence with Intracoastal Waterway	03080201	0.4		N	AE	2015
Little Haw Creek	Flagler County, Unincorporated Areas	Confluence with Haw Creek	Confluence of Lake Disston	03080103	7.5		N	A, AE	*
Long Creek	Flagler County, Unincorporated Areas; Palm Coast, City of	Confluence with Intracoastal Waterway	Confluence of Big Mulberry Branch	03080201	9.7		N	AE	2015
Matanzas River	Flagler County, Unincorporated Areas	Confluence with Intracoastal Waterway	County boundary	03080201	3.1		N	AE	2015
Middle Haw Creek	Bunnell, City of; Flagler County, Unincorporated Areas	State Route 11	Approximately 1.9 miles upstream of confluence of Middle Haw Creek Tributary No. 2	03080103	8.7		Y	AE	*

Table 2: Flooding Sources Included in this FIS Report, continued

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Middle Haw Creek	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Haw Creek	State Route 11	03080103	3.1		N	A	*
Middle Haw Creek Tributary No. 1	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Middle Haw Creek	State Route 11	03080103	1.2		Y	AE	*
Middle Haw Creek Tributary No. 2	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Middle Haw Creek	Approximately 80 feet upstream of Hudson Road No. 2	03080103	1.4		Y	AE	*
Parker Canal	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Black Branch	Confluence with Sweetwater Branch	03080103	7.3		N	AE	2001
Parkview Waterway	Palm Coast, City of	Palm Coast Parkway	Pine Lakes Parkway North	03080201	2.0		N	A	*
Pellicer Creek	Flagler County, Unincorporated Areas; Palm Coast, City of	Confluence with Matanzas River	Approximately 1.4 miles upstream of confluence of Hulett Branch	03080201	8.0		N	AE	2015
Pellicer Creek	Flagler County, Unincorporated Areas; Palm Coast, City of	Approximately 1.4 miles upstream of confluence of Hulett Branch	Confluence with Pringle Branch and Stevens Branch	03080201	0.2		N	A	*
Pringle Branch	Flagler County, Unincorporated Areas; Palm Coast, City of	Confluence with Stevens Branch and Pellicer Creek	Approximately 6.4 miles upstream of confluence with Stevens Branch and Pellicer Creek	03080201	6.4		N	A	*

Table 2: Flooding Sources Included in this FIS Report, continued

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Salt Creek	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Crescent Lake	Approximately 2.3 miles upstream of State Highway 100	03080103	3.0		N	A, AE	*
Sixteenmile Creek	Flagler County, Unincorporated Areas	County boundary	Approximately 1.4 miles upstream of county boundary	03080103	1.4		Y	AE	*
Stevens Branch	Flagler County, Unincorporated Areas	Confluence with Pringle Branch and Pellicer Creek	County boundary	03080201	1.2		N	A	*
Sweetwater Branch	Bunnell, City of; Flagler County, Unincorporated Areas	Confluence with Black Point Swamp	County Road 304	03080103	4.1		N	A	*
Sweetwater Branch	Bunnell, City of; Flagler County, Unincorporated Areas	State Route 304	Approximately 1 mile upstream of Hudson Road No. 2	03080103	4.8		Y	AE	*
Sweetwater Branch	Bunnell, City of	Approximately 1 mile upstream of Hudson Road No. 2	Approximately 1.9 miles upstream of Hudson Road No. 2	03080103	0.9		N	A	*
Tributary to Intracoastal Waterway	Palm Coast, City of	Confluence with Intracoastal Waterway	Approximately 1,840 feet upstream of confluence with Intracoastal Waterway	03080201	0.3		N	AE	2001
Wadsworth/Korona Canal	Flagler County, Unincorporated Areas; Palm Coast, City of	County boundary	Approximately 27 feet upstream of County Route 325	03080201	3.1		Y	AE	2001

Table 2: Flooding Sources Included in this FIS Report, continued

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Wadsworth/Korona Canal	Flagler County, Unincorporated Areas	Approximately 30 feet upstream of County Route 325	Approximately 1,270 feet upstream of County Route 325	03080201	0.2		N	A	*
Winfield Waterway	Palm Coast, City of	Confluence with Parkview Waterway	Approximately 0.5 miles upstream of Parkview Waterway	03080201	0.5		N	A	*

*Data not available

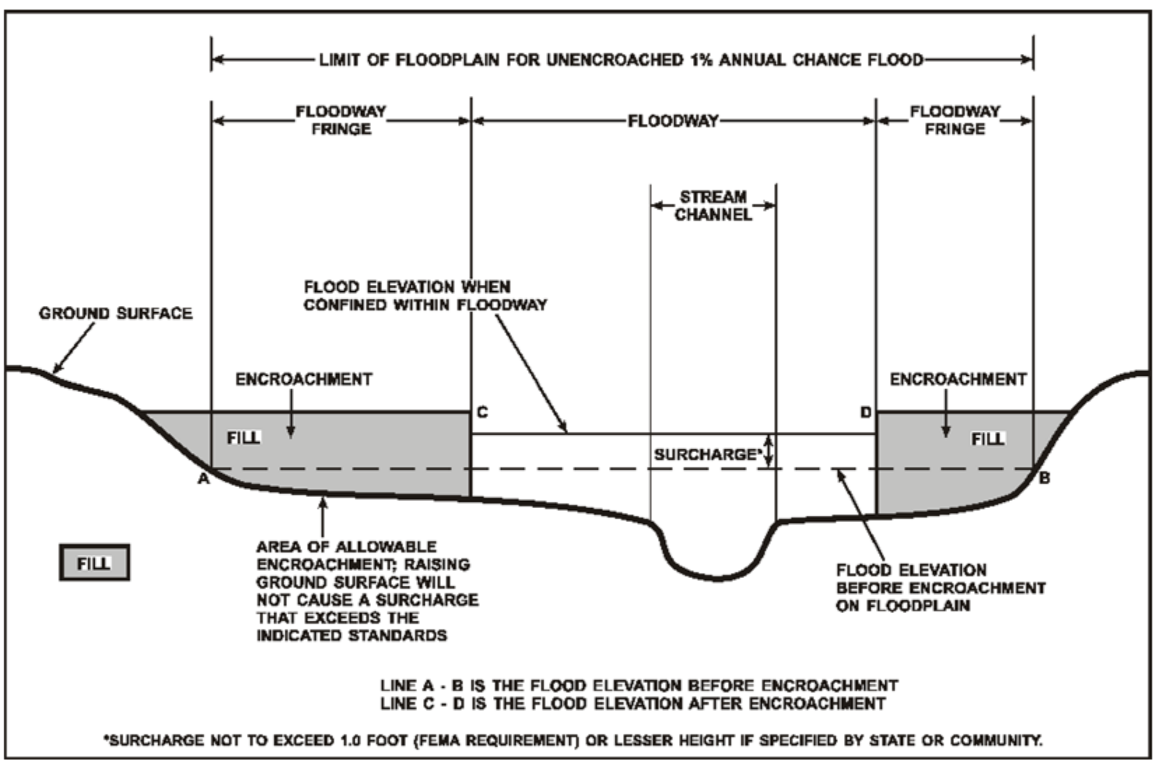
2.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard.

For purposes of the NFIP, a floodway is used as a tool to assist local communities in balancing floodplain development against increasing flood hazard. With this approach, the area of the 1% annual chance floodplain on a river is divided into a floodway and a floodway fringe based on hydraulic modeling. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment in order to carry the 1% annual chance flood. The floodway fringe is the area between the floodway and the 1% annual chance floodplain boundaries where encroachment is permitted. The floodway must be wide enough so that the floodway fringe could be completely obstructed without increasing the water surface elevation of the 1% annual chance flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.

To participate in the NFIP, Federal regulations require communities to limit increases caused by encroachment to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this project are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway projects.

Figure 4: Floodway Schematic



Floodway widths presented in this FIS Report and on the FIRM were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. For certain stream segments, floodways were adjusted so that the amount of floodwaters conveyed on each side of the floodplain would be reduced equally. The results of the floodway computations have been tabulated for selected cross sections and are shown in Table 24, "Floodway Data."

All floodways that were developed for this Flood Risk Project are shown on the FIRM using the symbology described in Figure 3. In cases where the floodway and l% annual chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown on the FIRM. For information about the delineation of floodways on the FIRM, refer to Section 6.3.

2.3 Base Flood Elevations

The hydraulic characteristics of flooding sources were analyzed to provide estimates of the elevations of floods of the selected recurrence intervals. The Base Flood Elevation (BFE) is the elevation of the 1% annual chance flood. These BFEs are most commonly rounded to the whole foot, as shown on the FIRM, but in certain circumstances or locations they may be rounded to 0.1 foot. Cross section lines shown on the FIRM may also be labeled with the BFE rounded to 0.1 foot. Whole-foot BFEs derived from engineering analyses that apply to coastal areas, areas of ponding, or other static areas with little elevation change may also be shown at selected intervals on the FIRM.

Cross sections with BFEs shown on the FIRM correspond to the cross sections shown in the Floodway Data table and Flood Profiles in this FIS Report. BFEs are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM.

2.4 Non-Encroachment Zones

Not applicable to this Flood Risk Project.

2.5 Coastal Flood Hazard Areas

For most areas along rivers, streams, and small lakes, BFEs and floodplain boundaries are based on the amount of water expected to enter the area during a 1% annual chance flood and the geometry of the floodplain. Floods in these areas are typically caused by storm events. However, for areas on or near ocean coasts, large rivers, or large bodies of water, BFE and floodplain boundaries may need to be based on additional components, including storm surges and waves. Communities on or near ocean coasts face flood hazards caused by offshore seismic events as well as storm events.

Coastal flooding sources that are included in this Flood Risk Project are shown in Table 2.

2.5.1 Water Elevations and the Effects of Waves

Specific terminology is used in coastal analyses to indicate which components have been included in evaluating flood hazards.

The stillwater elevation (SWEL or still water level) is the surface of the water resulting from astronomical tides, storm surge, and freshwater inputs, but excluding wave setup contribution or the effects of waves.

- *Astronomical tides* are periodic rises and falls in large bodies of water caused by the rotation of the earth and by the gravitational forces exerted by the earth, moon and sun.
- *Storm surge* is the additional water depth that occurs during large storm events. These events can bring air pressure changes and strong winds that force water up against the shore.
- *Freshwater inputs* include rainfall that falls directly on the body of water, runoff from surfaces and overland flow, and inputs from rivers.

The 1% annual chance stillwater elevation is the stillwater elevation that has been calculated for a storm surge from a 1% annual chance storm. The 1% annual chance storm surge can be determined from analyses of tidal gage records, statistical study of regional historical storms, or other modeling approaches. Stillwater elevations for storms of other frequencies can be developed using similar approaches.

The total stillwater elevation (also referred to as the mean water level) is the stillwater elevation plus wave setup contribution but excluding the effects of waves.

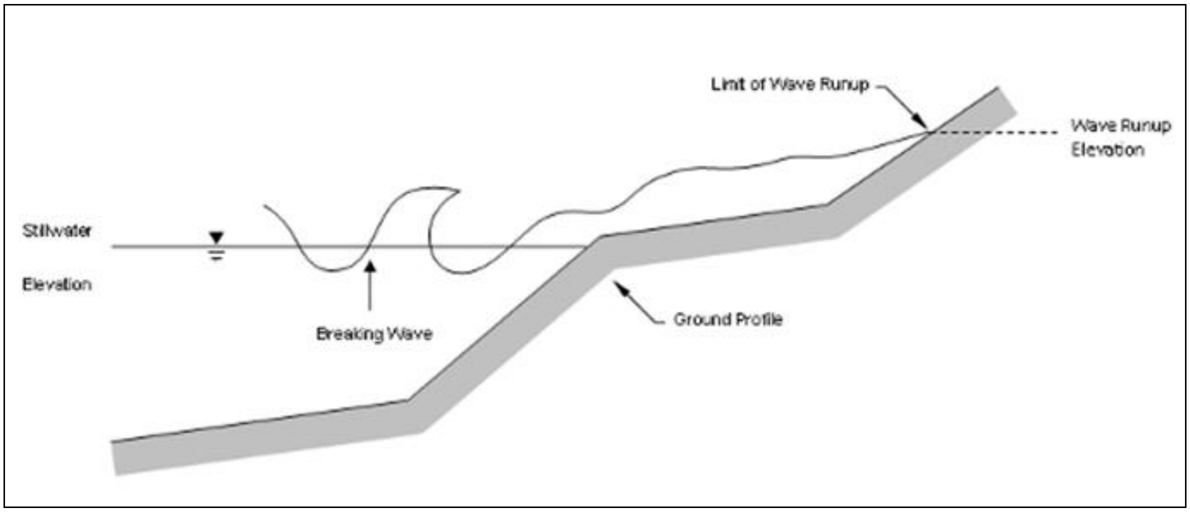
- *Wave setup* is the increase in stillwater elevation at the shoreline caused by the reduction of waves in shallow water. It occurs as breaking wave momentum is transferred to the water column.

Like the stillwater elevation, the total stillwater elevation is based on a storm of a particular frequency, such as the 1% annual chance storm. Wave setup is typically estimated using standard engineering practices or calculated using models, since tidal gages are often sited in areas sheltered from wave action and do not capture this information.

Coastal analyses may examine the effects of overland waves by analyzing storm-induced erosion, overland wave propagation, wave runup, and/or wave overtopping.

- *Storm-induced erosion* is the modification of existing topography by erosion caused by a specific storm event, as opposed to general erosion that occurs at a more constant rate.
- *Overland wave propagation* describes the combined effects of variation in ground elevation, vegetation, and physical features on wave characteristics as waves move onshore.
- *Wave runup* is the uprush of water from wave action on a shore barrier. It is a function of the roughness and geometry of the shoreline at the point where the stillwater elevation intersects the land.
- *Wave overtopping* refers to wave runup that occurs when waves pass over the crest of a barrier.

Figure 5: Wave Runup Transect Schematic



2.5.2 Floodplain Boundaries and BFEs for Coastal Areas

For coastal communities along the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and the Caribbean Sea, flood hazards must take into account how storm surges, waves, and extreme tides interact with factors such as topography and vegetation. Storm surge and waves must also be considered in assessing flood risk for certain communities on rivers or large inland bodies of water.

Beyond areas that are affected by waves and tides, coastal communities can also have riverine floodplains with designated floodways, as described in previous sections.

Floodplain Boundaries

In many coastal areas, storm surge is the principle component of flooding. The extent of the 1% annual chance floodplain in these areas is derived from the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1% annual chance storm. The methods that were used for calculation of total stillwater elevations for coastal areas are described in Section 5.3 of this FIS Report. Location of total stillwater elevations for coastal areas are shown in Figure 8, “1% Annual Chance Total Stillwater Levels for Coastal Areas.”

In some areas, the 1% annual chance floodplain is determined based on the limit of wave runup or wave overtopping for the 1% annual chance storm surge. The methods that were used for calculation of wave hazards are described in Section 5.3 of this FIS Report.

Table 26 presents the types of coastal analyses that were used in mapping the 1% annual chance floodplain in coastal areas.

Coastal BFEs

Coastal BFEs are calculated as the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1% annual chance storm plus the additional flood hazard from overland wave effects (storm-induced erosion, overland wave propagation, wave runup and wave overtopping).

Where they apply, coastal BFEs are calculated along transects extending from offshore to the limit of coastal flooding onshore. Results of these analyses are accurate until local topography, vegetation, or development type and density within the community undergoes major changes.

Parameters that were included in calculating coastal BFEs for each transect included in this FIS Report are presented in Table 17, “Coastal Transect Parameters.” The locations of transects are shown in Figure 9, “Transect Location Map.” More detailed information about the methods used in coastal analyses and the results of intermediate steps in the coastal analyses are presented in Section 5.3 of this FIS Report. Additional information on specific mapping methods is provided in Section 6.4 of this FIS Report.

2.5.3 Coastal High Hazard Areas

Certain areas along the open coast and other areas may have higher risk of experiencing structural damage caused by wave action and/or high-velocity water during the 1% annual chance flood. These areas will be identified on the FIRM as Coastal High Hazard Areas.

- *Coastal High Hazard Area (CHHA)* is a SFHA extending from offshore to the inland limit of the primary frontal dune (PFD) or any other area subject to damages caused by wave action and/or high-velocity water during the 1% annual chance flood.
- *Primary Frontal Dune (PFD)* is a continuous or nearly continuous mound or ridge of sand with relatively steep slopes immediately landward and adjacent to the beach. The PFD is subject to erosion and overtopping from high tides and waves during major coastal storms.

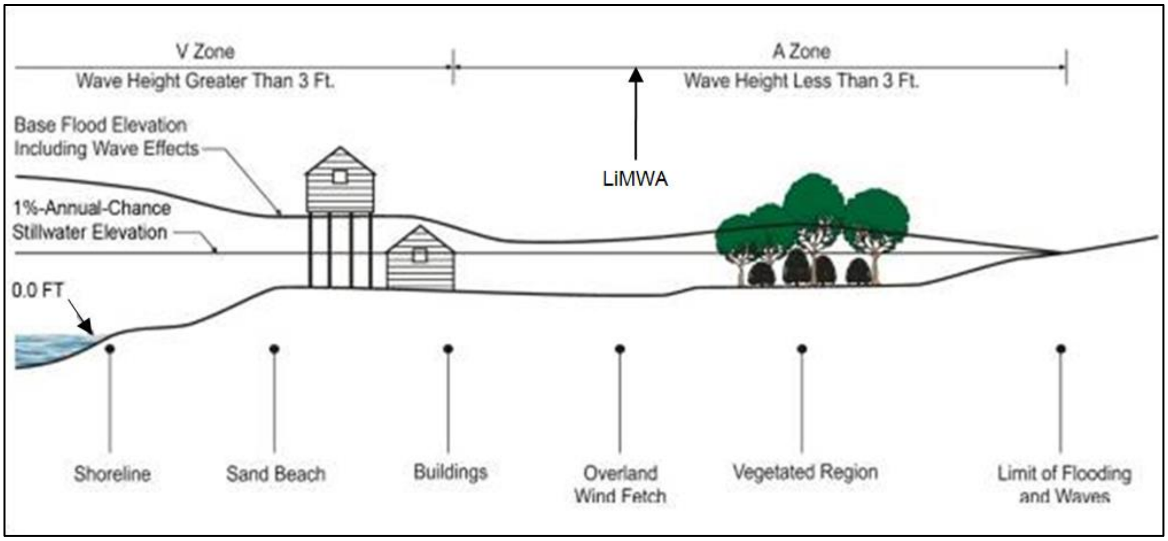
CHHAs are designated as “V” zones (for “velocity wave zones”) and are subject to more stringent regulatory requirements and a different flood insurance rate structure. The areas of greatest risk are shown as VE on the FIRM. Zone VE is further subdivided into elevation zones and shown with BFEs on the FIRM.

The landward limit of the PFD occurs at a point where there is a distinct change from a relatively steep slope to a relatively mild slope; this point represents the landward extension of Zone VE. Areas of lower risk in the CHHA are designated with Zone V on the FIRM. More detailed information about the identification and designation of Zone VE is presented in Section 6.4 of this FIS Report.

Areas that are not within the CHHA but are SFHAs may still be impacted by coastal flooding and damaging waves; these areas are shown as “A” zones on the FIRM.

Figure 6, “Coastal Transect Schematic,” illustrates the relationship between the base flood elevation, the 1% annual chance stillwater elevation, and the ground profile as well as the location of the Zone VE and Zone AE areas in an area without a PFD subject to overland wave propagation. This figure also illustrates energy dissipation and regeneration of a wave as it moves inland.

Figure 6: Coastal Transect Schematic



Methods used in coastal analyses in this Flood Risk Project are presented in Section 5.3 and mapping methods are provided in Section 6.4 of this FIS Report.

Coastal floodplains are shown on the FIRM using the symbology described in Figure 3, "Map Legend for FIRM." In many cases, the BFE on the FIRM is higher than the stillwater elevations shown in Table 17 due to the presence of wave effects. The higher elevation should be used for construction and/or floodplain management purposes.

2.5.4 Limit of Moderate Wave Action

Laboratory tests and field investigations have shown that wave heights as little as 1.5 feet can cause damage to and failure of typical Zone AE building construction. Wood-frame, light gage steel, or masonry walls on shallow footings or slabs are subject to damage when exposed to waves less than 3 feet in height. Other flood hazards associated with coastal waves (floating debris, high velocity flow, erosion, and scour) can also damage Zone AE construction.

Therefore, a LiMWA boundary may be shown on the FIRM as an informational layer to assist coastal communities in safe rebuilding practices. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The location of the LiMWA relative to Zone VE and Zone AE is shown in Figure 6.

The effects of wave hazards in Zone AE between Zone VE (or the shoreline where Zone VE is not identified) and the limit of the LiMWA boundary are similar to, but less severe than, those in Zone VE where 3-foot or greater breaking waves are projected to occur during the 1% annual chance flooding event. Communities are therefore encouraged to adopt and enforce more stringent floodplain management requirements than the minimum NFIP requirements in the LiMWA. The NFIP Community Rating System provides credits for these actions.

Within the limit of Flagler County, areas with less than 3 feet in height were not identified along the open coast shoreline. Within the Intercoastal Water Ways wave regeneration occurred but did not reach conditions to determine the mapping of a Zone VE. As a result, in the county, LiMWA was not mapped indicating the presence of wave heights greater than 3 feet or smaller than 1.5 feet.

SECTION 3.0 – INSURANCE APPLICATIONS

3.1 National Flood Insurance Program Insurance Zones

For flood insurance applications, the FIRM designates flood insurance rate zones as described in Figure 3, "Map Legend for FIRM." Flood insurance zone designations are assigned to flooding sources based on the results of the hydraulic or coastal analyses. Insurance agents use the zones shown on the FIRM and depths and base flood elevations in this FIS Report in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

The 1% annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (e.g. Zones A, AE, V, VE, etc.), and the 0.2% annual chance floodplain boundary corresponds to the boundary of areas of additional flood hazards.

Table 3 lists the flood insurance zones in Flagler County.

Table 3: Flood Zone Designations by Community

Community	Flood Zone(s)
Beverly Beach, Town of	AE, VE, X
Bunnell, City of	A, AE, X
Flagler Beach, City of	AE, VE, X
Flagler County, Unincorporated Areas	A, AE, AO, VE, X
Marineland, Town of	AE, AO, VE, X
Palm Coast, City of	A, AE, X

3.2 Coastal Barrier Resources System

The Coastal Barrier Resources Act (CBRA) of 1982 was established by Congress to create areas along the Atlantic and Gulf coasts and the Great Lakes, where restrictions for Federal financial assistance including flood insurance are prohibited. In 1990, Congress passed the Coastal Barrier Improvement Act (CBIA), which increased the extent of areas established by the CBRA and added "Otherwise Protected Areas" (OPA) to the system. These areas are collectively referred to as the John. H Chafee Coastal Barrier Resources System (CBRS). The CBRS boundaries that have been identified in the project area are in Table 4, "Coastal Barrier Resource System Information."

Table 4: Coastal Barrier Resources System Information

Primary Flooding Source	CBRS/OPA Type	Date CBRS Area Established	FIRM Panel Number(s)
Atlantic Ocean	OPA	11/16/1991	12035C0253E 12035C0261E

Table 4: Coastal Barrier Resources System Information, continued

Primary Flooding Source	CBRS/OPA Type	Date CBRS Area Established	FIRM Panel Number(s)
Atlantic Ocean	OPA	11/16/1991	12035C0038E 12035C0039E 12035C0126E 12035C0127E
Atlantic Ocean	CBRS	10/01/1983	12035C0037E
Pellicer Creek	CBRS	11/16/1990	12035C0017E 12035C0036E 12035C0037E

SECTION 4.0 – AREA STUDIED

4.1 Basin Description

Table 5 contains a description of the characteristics of the HUC-8 sub-basins within which each community falls. The table includes the main flooding sources within each basin, a brief description of the basin, and its drainage area.

Table 5: Basin Characteristics

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Daytona – St. Augustine	03080201	Atlantic Ocean	Northern county boundary to southern county boundary	155
Lower St. Johns	03080103	*	*	357

*Data not available

4.2 Principal Flood Problems

Table 6 contains a description of the principal flood problems that have been noted for Flagler County by flooding source.

Table 6: Principal Flood Problems

Flooding Source	Description of Flood Problems
Atlantic Ocean	The wave action associated with storm surge can be much more damaging than the high water level. Surge can also penetrate through the ICCW and flood the lower inland area. Not all storms that pass close to the study area produce extremely high surge.

Table 6: Principal Flood Problems, continued

Flooding Source	Description of Flood Problems
All Sources within Flagler County	The major sources of flooding in Flagler County are storm surge and waves associated with a northeaster, hurricane, or tropical storm activity and overflow of streams and swamps associated with rainfall runoff. Major rainfall events occur from hurricanes, tropical storms, and thundershowers associated with frontal systems. Heavy rainfall can also cause ponding in low-lying areas and cause local drainage problems. Storms that produce flooding conditions in one area may not necessarily produce flooding conditions in other parts of the study area. Much of the county's flood-prone areas feature poorly drained soil, a high water table, and flat terrain. These characteristics contribute significantly to flooding problems.

Table 7 contains information about historic flood elevations in the communities within Flagler County.

Table 7: Historic Flooding Elevations

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Atlantic Ocean	Northeast Florida coastline	11.0	1964	*	*
Atlantic Ocean	Northeast Florida coastline	4.2	2004		NOAA Tide Records, 8720651
Atlantic Ocean	Northeast Florida coastline	3.9	2004		NOAA Tide Records, 8720582
Atlantic Ocean	Northeast Florida coastline	3.3	2004		NOAA Tide Records, 8720757
Atlantic Ocean	Northeast Florida coastline	2.9	2005		NOAA Tide Records, 8720757

*Data not available

4.3 Non-Levee Flood Protection Measures

Table 8 contains information about non-levee flood protection measures within Flagler County such as dams, jetties, and or dikes. Levees are addressed in Section 4.4 of this FIS Report.

Table 8: Non-Levee Flood Protection Measures

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Atlantic Ocean	N/A	Seawalls and Revetments	Along the shoreline	Protection against erosion
Intracoastal Waterway	N/A	Seawall	Along Intracoastal Waterway	Protection against erosion
Intracoastal Waterway	N/A	Bulkheads	Along Intracoastal Waterway	Protection against erosion

4.4 Levees

This section is not applicable to this Flood Risk Project.

Table 9: Levees

[Not Applicable to this Flood Risk Project]

SECTION 5.0 – ENGINEERING METHODS

For the flooding sources in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded at least once on the average during any 10-, 25-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 25-, 50-, 100-, and 500-year floods, have a 10-, 4-, 2-, 1-, and 0.2% annual chance, respectively, of being equaled or exceeded during any year.

Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedance) during the term of a 30-year mortgage is approximately 26 percent (about 3 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

The engineering analyses described here incorporate the results of previously issued Letters of Map Change (LOMCs) listed in Table 27, "Incorporated Letters of Map Change", which include Letters of Map Revision (LOMRs). For more information about LOMRs, refer to Section 6.5, "FIRM Revisions."

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. A summary of the hydrologic methods applied to develop the discharges used in the hydraulic analyses for each stream is provided in Table 13. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 10. Frequency Discharge-Drainage Area Curves used to develop the hydrologic models may also be shown in
Figure 7 for selected flooding sources. A summary of stillwater elevations developed for non-coastal flooding sources is provided in Table 11. (Coastal stillwater elevations are discussed in Section 5.3 and shown in Table 17.) Stream gage information is provided in Table 12.

Table 10: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Big Mulberry Branch	At confluence with Unnamed Canal	4.46	900	1,130	*	1,440	1,800
Black Branch	At confluence with Haw Creek	30.20	3,053	3,779	*	4,984	6,415
Black Branch	At State Route 11	9.6	860	1,070	*	1,370	1,710
Black Point Swamp	At confluence with Black Branch	8.1	880	1,130	*	1,460	1,850
Black Point Swamp	At State Road 302/100	2.6	550	700	*	890	1,110
Bull Creek	At confluence with Crescent Lake	30.20	1,166	1,483	*	1,860	2,386
Bull Creek	At confluence of Bull Creek Tributary	26.80	1,798	2,163	*	2,673	3,306
Bull Creek Tributary	At confluence with Bull Creek	20.20	1,166	1,483	*	1,860	2,386
Bulow Creek	At county boundary	20.49	1,320	1,700	*	2,220	2,860
Bulow Creek	At Old Kings Road	6.6	480	590	*	750	930
Bulow Creek Tributary	At confluence with Bulow Creek	11.9	950	1,200	*	1,530	1,920
Graham Swamp	At confluence with Intracoastal Waterway	29.7	950	1,200	*	1,340	1,580
Graham Swamp	At State Route 100	11.1	420	570	*	660	840

Table 10: Summary of Discharges, continued

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Haw Creek	At confluence with Crescent Lake	359.60	11,290	14,310	*	18,630	23,487
Haw Creek	Upstream of confluence of Middle Haw Creek	109.3	4,640	5,850	*	7,800	10,040
Middle Haw Creek	At State Route 304	62.8	2,380	*	4,130	5,005	7,485
Middle Haw Creek	At the confluence of Middle Haw Creek Tributary No. 1	59.0	2,304	*	3,995	4,845	7,240
Middle Haw Creek	At the confluence of Middle Haw Creek Tributary No. 2	36.3	1,460	*	2,575	3,135	4,765
Middle Haw Creek Tributary No. 1	At State Road 11	4.1	475	*	855	1,040	1,585
Middle Haw Creek Tributary No. 2	At the confluence with Middle Haw Creek	1.7	185	*	345	425	685
Parker Canal	At confluence with Black Branch	45	1,700	2,220	*	2,970	2,860
Parker Canal	At County Route 304	21.7	1,050	1,350	*	1,770	2,310
Sixteenmile Creek	At headwater	1.9	250	*	450	560	870

Table 10: Summary of Discharges, continued

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Sweetwater Branch	At State Route 304	30.0	1,320	*	2,330	2,845	4,400
Sweetwater Branch	At the confluence of Parker Canal	21.2	1,030	*	1,835	2,245	3,490
Wadsworth/ Korona Canal	At Old Kings Road	11.0	800	1,020	*	1,320	1,690

*Not calculated for this Flood Risk Project

Figure 7: Frequency Discharge-Drainage Area Curves

[Not Applicable to this Flood Risk Project]

Table 11: Summary of Non-Coastal Stillwater Elevations

Flooding Source	Location	Elevations (feet NAVD88)				
		10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Crescent Lake	Along shoreline	4.2	*	5.7	6.3	7.6

*Not calculated for this Flood Risk Project

Table 12: Stream Gage Information used to Determine Discharges

[Not Applicable to this Flood Risk Project]

5.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Base flood elevations on the FIRM represent the elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations. These whole-foot elevations may not exactly reflect the elevations derived from the hydraulic analyses. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For streams for which hydraulic analyses were based on cross sections, locations of selected cross sections are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 6.3), selected cross sections are also listed on Table 24, “Floodway Data.”

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 13. Roughness coefficients are provided in Table 14. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Table 13: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Atlantic Ocean	Entire coastline	Entire coastline	ADCIRC+ SWAN	JPM-OS	2015	VE	Offshore starting wave conditions are required for 1-D transect-based wave hazard analysis. As part of the JPM-OS ADCIRC+SWAN regional hydrodynamic and wave modeling significant wave heights and peak wave periods were produced at each node contained in the ADCIRC mesh. These results provided valuable information on the wave conditions that can be expected to occur during the types of extreme storm events that would produce storm surge elevations with 1- and 0.2-percent-annual-chance probabilities of occurrence. Results from the ADCIRC+SWAN modeling were used to develop starting wave conditions for the coastal hazard analyses within the study area. The Joint Probability Method with Optimal Sampling (JPM-OS) was applied to compute Stillwater Elevations (SWELs). The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Big Mulberry Branch	Confluence with Intracoastal Waterway	Approximately 1,584 feet upstream of Palm Harbor Parkway	*	*	2015	AE w/ Floodway	Combined probability analysis was calculated for each riverine cross section that intersected the coastal surge. The 1%- and 0.2%-annual-chance combined probability results were mapped using LiDAR data (Merrick & Co., 2004).
Big Mulberry Branch	Approximately 1,584 feet upstream of Palm Harbor Parkway	Approximately 0.70 miles upstream of Belle Terre Parkway	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Big Mulberry Branch (continued)	Approximately 1,584 feet upstream of Palm Harbor Parkway	Approximately 0.70 miles upstream of Belle Terre Parkway	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution. Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Big Mulberry Branch (continued)	Approximately 1,584 feet upstream of Palm Harbor Parkway	Approximately 0.70 miles upstream of Belle Terre Parkway	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D. From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in *Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida*, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Channel cross sections were acquired by field survey. Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. Structure data were obtained from the county's Stormwater Structure Inventory plan where available (Professional Engineering Consultants, Inc., 1997). All other structure data were obtained from field surveys. The water-surface elevations are calculated from discharges estimated from the hydrologic model.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Big Mulberry Branch (continued)	Approximately 1,584 feet upstream of Palm Harbor Parkway	Approximately 0.70 miles upstream of Belle Terre Parkway	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	From approximately 1,584 feet upstream of Palm Harbor Parkway to approximately 975 feet downstream of Belle Terre Parkway the floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004). From approximately 975 feet downstream of Belle Terre Parkway to the limit of study the effective mapping was retained and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Black Branch	Confluence with Haw Creek	Approximately 0.75 miles upstream of Old Haw Creek Road	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution. Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Black Branch (continued)	Confluence with Haw Creek	Approximately 0.75 miles upstream of Old Haw Creek Road	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D. From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in *Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida*, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Channel cross sections were acquired by field survey.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Black Branch (continued)	Confluence with Haw Creek	Approximately 0.75 miles upstream of Old Haw Creek Road	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. Structure data were obtained from the county's Stormwater Structure Inventory plan where available (Professional Engineering Consultants, Inc., 1997). All other structure data were obtained from field surveys. The water-surface elevations are calculated from discharges estimated from the hydrologic model. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004) from the confluence with Haw Creek to approximately 1,860 feet upstream of State Highway 11. From approximately 1,860 feet upstream of State Highway 11 to approximately 0.75 miles upstream of Old Haw Creek Road the effective mapping was retained and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Black Branch	Approximately 0.75 miles upstream of Old Haw Creek Road	Approximately 1.1 miles upstream of Old Haw Creek Road	*	*	*	A	*
Black Point Swamp	Confluence with Haw Creek	State Road 302/100	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Black Point Swamp (continued)	Confluence with Haw Creek	State Road 302/100	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution. Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D. From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Black Point Swamp (continued)	Confluence with Haw Creek	State Road 302/100	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in *Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida*, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Channel cross sections were acquired by field survey. Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. Structure data were obtained from the county's Stormwater Structure Inventory plan where available (Professional Engineering Consultants, Inc., 1997). All other structure data were obtained from field surveys. The water-surface elevations are calculated from discharges estimated from the hydrologic model. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Black Point Swamp	State Road 302/100	Approximately 1,863 feet upstream of State Road 302/100	*	*	*	A	*

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bull Creek	Confluence with Crescent Lake	Approximately 1,400 feet downstream of confluence of Bull Creek Tributary	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution. Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bull Creek (continued)	Confluence with Crescent Lake	Approximately 1,400 feet downstream of confluence of Bull Creek Tributary	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE	As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D. From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in *Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida*, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Channel cross sections were acquired by field survey. Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. Structure data were obtained from the county's Stormwater Structure Inventory plan where available (Professional Engineering Consultants, Inc., 1997). All other structure data were obtained from field surveys. The water-surface elevations are calculated from discharges estimated from the hydrologic model.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bull Creek (continued)	Confluence with Crescent Lake	Approximately 1,400 feet downstream of confluence of Bull Creek Tributary	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE	The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004) from the confluence with Crescent Lake to approximately 3 miles upstream of the confluence with Crescent Lake. From approximately 3 miles upstream of the confluence with Crescent Lake to approximately 70 feet upstream of State Route 100 the effective mapping was retained and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Bull Creek	Approximately 1,400 feet downstream of confluence of Bull Creek Tributary	Approximately 70 feet upstream of State Route 100	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bull Creek (continued)	Approximately 1,400 feet downstream of confluence of Bull Creek Tributary	Approximately 70 feet upstream of State Route 100	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D. From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in *Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida*, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bull Creek (continued)	Approximately 1,400 feet downstream of confluence of Bull Creek Tributary	Approximately 70 feet upstream of State Route 100	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	Channel cross sections were acquired by field survey. Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. Structure data were obtained from the county's Stormwater Structure Inventory plan where available (Professional Engineering Consultants, Inc., 1997). All other structure data were obtained from field surveys. The water-surface elevations are calculated from discharges estimated from the hydrologic model. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004) from the confluence with Crescent Lake to approximately 3 miles upstream of the confluence with Crescent Lake. From approximately 3 miles upstream of the confluence with Crescent Lake to approximately 70 feet upstream of State Route 100 the effective mapping was retained and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Bull Creek Tributary	Confluence with Bull Creek	Approximately 28 feet upstream of County Route 305	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bull Creek Tributary (continued)	Confluence with Bull Creek	Approximately 28 feet upstream of County Route 305	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution. Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bull Creek Tributary (continued)	Confluence with Bull Creek	Approximately 28 feet upstream of County Route 305	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Channel cross sections were acquired by field survey. Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. Structure data were obtained from the county's Stormwater Structure Inventory plan where available (Professional Engineering Consultants, Inc., 1997). All other structure data were obtained from field surveys. The water-surface elevations are calculated from discharges estimated from the hydrologic model.
Bulow Creek	Flagler/Volusia County boundary	Approximately 4.9 miles upstream of Flagler/Volusia County boundary	*	*	2015	AE w/ Floodway	Combined probability analysis was calculated for each riverine cross section that intersected the coastal surge. The 1%- and 0.2%-annual-chance combinec probability results were mapped using LiDAR data (Merrick & Co., 2004).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bulow Creek	Approximately 4.9 miles upstream of Flagler/Volusia County boundary	Approximately 5.2 miles upstream of Flagler/Volusia County boundary	*	*	2006	AE w/ Floodway	*
Bulow Creek	Approximately 5.2 miles upstream of Flagler/Volusia County boundary	Approximately 75 feet upstream of Old Kings Road	AdICPR 2.11 and USACE HEC-HMS 1.0	AdICPR 2.11	2001	AE w/ Floodway	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution. Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bulow Creek (continued)	Approximately 5.2 miles upstream of Flagler/Volusia County boundary	Approximately 75 feet upstream of Old Kings Road	AdICPR 2.11 and USACE HEC-HMS 1.0	AdICPR 2.11	2001	AE w/ Floodway	Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D. From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Bulow Creek was modeled using the AdICPR version 2.11. This is a dynamic (non-steady state) model that is better suited to model the complicated flow patterns of these systems. The Bulow Creek system has a split flow at the confluence with the ICCW that could not be modeled accurately using HEC-RAS.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bulow Creek (continued)	Approximately 5.2 miles upstream of Flagler/Volusia County boundary	Approximately 75 feet upstream of Old Kings Road	AdICPR 2.11 and USACE HEC-HMS 1.0	AdICPR 2.11	2001	AE w/ Floodway	The AdICPR model utilizes a simplified version of the momentum equation, commonly referred to as the energy equation, to compute discharges and water-surface elevations. Input parameters include downstream starting water-surface elevations, discharges, channel cross sections, structure dimensions, and roughness factors (Manning's "n"). Channel roughness factors (Manning's "n") used in the hydraulic computations were determined by engineering judgement shaped by field observations, aerial photographs, and published text with photographs and recommended roughness values. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Bulow Creek Tributary	Confluence with Bulow Creek	Approximately 0.89 miles upstream of confluence with Bulow Creek	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bulow Creek Tributary (continued)	Confluence with Bulow Creek	Approximately 0.89 miles upstream of confluence with Bulow Creek	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution. Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D. From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bulow Creek Tributary (continued)	Confluence with Bulow Creek	Approximately 0.89 miles upstream of confluence with Bulow Creek	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Channel cross sections were acquired by field survey. Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. The water-surface elevations are calculated from discharges estimated from the hydrologic model. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Bulow Creek Tributary	Approximately 0.89 miles upstream of confluence with Bulow Creek	Approximately 0.93 miles upstream of confluence with Bulow Creek	*	*	*	A	*
Crescent Lake	County boundary	Confluence of Haw Creek	AdICPR 2.11 and USACE HEC-HMS 1.0	Log-Pearson Type III and Regression Analysis	*	AE	No lake-level records have been collected for Crescent Lake. Lake-level records for 12 lakes in Alachua, Clay and Marion Counties were used to define maximum lake volume-frequency relationships for the site. Flood-frequency curves were defined for each of the 12 lake-level records. These curves were developed in terms of lake volume measured above a defined base. Volumes were adjusted for outflow, as applicable, and the base level was defined as the mean lake stage.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Crescent Lake (continued)	County boundary	Confluence of Haw Creek	AdICPR 2.11 and USACE HEC-HMS 1.0	Log-Pearson Type III and Regression Analysis	*	AE	A log-Pearson Type III distribution, using the average skew coefficient as outlined in U.S. Water Resources Council Bulletin 17A (U.S. Water Resources Council, 1976), was found to be an acceptable technique for fitting flood-frequency curves to the lake volume data. Values of the 10-, 50-, 100-, and 500-year volumes were obtained for each of the 12 lakes from this log-Pearson Type III distribution. Regression analysis was also used to define a regional relationship between the mean lake stage and grassline elevation along the shores of the 12 lakes. The analysis showed that the elevation of the grassline along the shoreline explained nearly all of the variation in mean lake stage. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Dave Branch	Confluence with Pringle Branch	Approximately 4,270 feet upstream of confluence with Pringle Branch	*	*	*	A	The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Dead Lake	Confluence with Crescent Lake	Confluence with Bull Creek	*	*	*	AE	The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Fox Cut Waterway	Convergence with Intracoastal Waterway	Convergence from Intracoastal Waterway	ADCIRC+ SWAN	JPM-OS	2015	AE	Offshore starting wave conditions are required for 1-D transect-based wave hazard analysis. As part of the JPM-OS ADCIRC+SWAN regional hydrodynamic and wave modeling significant wave heights and peak wave periods were produced at each node contained in the ADCIRC mesh.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Fox Cut Waterway (continued)	Convergence with Intracoastal Waterway	Convergence from Intracoastal Waterway	ADCIRC+ SWAN	JPM-OS	2015	AE	These results provided valuable information on the wave conditions that can be expected to occur during the types of extreme storm events that would produce storm surge elevations with 1- and 0.2-percent-annual-chance probabilities of occurrence. Results from the ADCIRC+SWAN modeling were used to develop starting wave conditions for the coastal hazard analyses within the study area. The Joint Probability Method with Optimal Sampling (JPM-OS) was applied to compute Stillwater Elevations (SWELs). The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Gore Lake	Approximately 1,840 feet upstream of Laguna Forest Trail	Approximately 5,200 feet upstream of Laguna Forest Trail	*	*	*	A	*
Graham Swamp	Confluence with Intracoastal Waterway	Approximately 0.7 miles upstream of Colbert Lane	*	*	2015	AE	Combined probability analysis was calculated for each riverine cross section that intersected the coastal surge. The 1%- and 0.2%-annual-chance combined probability results were mapped using LiDAR data (Merrick & Co., 2004).
Graham Swamp	Approximately 0.7 miles upstream of Colbert Lane	Approximately 4.2 miles upstream of Colbert Lane	AdICPR 2.11 and USACE HEC-HMS 1.0	AdICPR 2.11	2001	AE	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Graham Swamp (continued)	Approximately 0.7 miles upstream of Colbert Lane	Approximately 4.2 miles upstream of Colbert Lane	AdICPR 2.11 and USACE HEC-HMS 1.0	AdICPR 2.11	2001	AE	The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. Graham Swamp was modeled using AdICPR version 2.11. This is a dynamic (non-steady state) model that is better suited to model the complicated flow patterns of these systems. The AdICPR model utilizes a simplified version of the momentum equation, commonly referred to as the energy equation, to compute discharges and water-surface elevations. Input parameters include downstream starting water-surface elevations, discharges, channel cross sections, structure dimensions, and roughness factors (Manning's "n"). Channel roughness factors (Manning's "n") were determined by engineering judgement shaped by field observations, aerial photographs, and published text with photographs and recommended roughness values. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Haw Creek	Confluence with Crescent Lake	Confluence of Black Point Swamp and Black Branch	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Haw Creek (continued)	Confluence with Crescent Lake	Confluence of Black Point Swamp and Black Branch	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution. Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Haw Creek (continued)	Confluence with Crescent Lake	Confluence of Black Point Swamp and Black Branch	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in *Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida*, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Channel cross sections were acquired by field survey. Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. Structure data were obtained from the county’s Stormwater Structure Inventory plan where available (Professional Engineering Consultants, Inc., 1997). All other structure data were obtained from field surveys. The water-surface elevations are calculated from discharges estimated from the hydrologic model. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Hulett Branch	Approximately 1 mile upstream of confluence with Pellicer Creek	Approximately 1.3 mile upstream of confluence with Pellicer Creek	*	*	*	A, AE	Coastal backwater effects from the Atlantic Ocean applied from the confluence with Pellicer Creek to approximately 1 mile upstream of confluence with Pellicer Creek. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Intracoastal Waterway	County boundary with Volusia County	County boundary with St. Johns County	ADCIRC+ SWAN	JPM-OS	2015	AE	Offshore starting wave conditions are required for 1-D transect-based wave hazard analysis. As part of the JPM-OS ADCIRC+SWAN regional hydrodynamic and wave modeling significant wave heights and peak wave periods were produced at each node contained in the ADCIRC mesh. These results provided valuable information on the wave conditions that can be expected to occur during the types of extreme storm events that would produce storm surge elevations with 1- and 0.2-percent-annual-chance probabilities of occurrence. Results from the ADCIRC+SWAN modeling were used to develop starting wave conditions for the coastal hazard analyses within the study area. The Joint Probability Method with Optimal Sampling (JPM-OS) was applied to compute Stillwater Elevations (SWELs). The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Lake Disston	Confluence with Little Haw Creek	Approximately 1.5 miles upstream of confluence with Little Haw Creek	*	*	*	A	*

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Lambert Cove	Confluence with Intracoastal Waterway	Approximately 2,330 feet upstream of confluence with Intracoastal Waterway	ADCIRC+ SWAN	JPM-OS	2015	AE	Offshore starting wave conditions are required for 1-D transect-based wave hazard analysis. As part of the JPM-OS ADCIRC+SWAN regional hydrodynamic and wave modeling significant wave heights and peak wave periods were produced at each node contained in the ADCIRC mesh. These results provided valuable information on the wave conditions that can be expected to occur during the types of extreme storm events that would produce storm surge elevations with 1- and 0.2-percent-annual-chance probabilities of occurrence. Results from the ADCIRC+SWAN modeling were used to develop starting wave conditions for the coastal hazard analyses within the study area. The Joint Probability Method with Optimal Sampling (JPM-OS) was applied to compute Stillwater Elevations (SWELs). The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Little Haw Creek	Confluence with Haw Creek	Confluence of Lake Disston	*	*	*	A, AE	Backwater effects from Crescent Lake were applied from the confluence with Haw Creek to approximately 2 miles upstream of the confluence with Haw Creek. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Long Creek	Confluence with Intracoastal Waterway	Confluence of Big Mulberry Branch	ADCIRC+ SWAN	JPM-OS	2015	AE	Offshore starting wave conditions are required for 1-D transect-based wave hazard analysis. As part of the JPM-OS ADCIRC+SWAN regional hydrodynamic and wave modeling significant wave heights and peak wave periods were produced at each node contained in the ADCIRC mesh.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Long Creek (continued)	Confluence with Intracoastal Waterway	Confluence of Big Mulberry Branch	ADCIRC+ SWAN	JPM-OS	2015	AE	These results provided valuable information on the wave conditions that can be expected to occur during the types of extreme storm events that would produce storm surge elevations with 1- and 0.2-percent-annual-chance probabilities of occurrence. Results from the ADCIRC+SWAN modeling were used to develop starting wave conditions for the coastal hazard analyses within the study area. The Joint Probability Method with Optimal Sampling (JPM-OS) was applied to compute Stillwater Elevations (SWELs). The floodplain boundary was mapped using LiDAR data (Merrick and Co. 2004).
Matanzas River	Confluence with Intracoastal Waterway	County boundary	ADCIRC+ SWAN	JPM-OS	2015	AE	Offshore starting wave conditions are required for 1-D transect-based wave hazard analysis. As part of the JPM-OS ADCIRC+SWAN regional hydrodynamic and wave modeling significant wave heights and peak wave periods were produced at each node contained in the ADCIRC mesh. These results provided valuable information on the wave conditions that can be expected to occur during the types of extreme storm events that would produce storm surge elevations with 1- and 0.2-percent-annual-chance probabilities of occurrence. Results from the ADCIRC+SWAN modeling were used to develop starting wave conditions for the coastal hazard analyses within the study area. The Joint Probability Method with Optimal Sampling (JPM-OS) was applied to compute Stillwater Elevations (SWELs). The floodplain boundary was mapped using LiDAR data (Merrick and Co. 2004).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Middle Haw Creek	Confluence with Haw Creek	State Route 11	*	*	*	A, AE	Backwater effects from Crescent Lake applied from the confluence with Haw Creek to approximately 0.5 miles upstream of County Road 305. The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004) from the confluence with Haw Creek to approximately 2.7 miles upstream of County Road 203. From 2.7 miles upstream of County Road 203 to State Route 11 the floodplain boundary was mapped by retaining the effective data and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Middle Haw Creek	State Route 11	Approximately 1.5 miles upstream of confluence of Middle Haw Creek Tributary No. 2	Regionalized Regression Equations	USACE HEC-2	*	AE w/ Floodway	Regionalized regression equations developed by the USGS in cooperation with the Florida Department of Transportation were used for deriving peak discharge-frequency relationships. Master drainage plans for the Palm Coast development were obtained from the ITT Corporation (Sverdrup & Parcel and Associates, Inc., Project 5089, 1977; Sverdrup & Parcel and Associates, Inc., Project 5089A). Drainage calculations on the Smoketalk Ridge Subdivision in south Flagler County were obtained from the County Engineer's office (Zahn and Gliger Engineering, Inc., 1982). The hydrologic calculations for the study area are detailed in Tetra Tech WRE Note 83-5 (Tetra Tech, Inc., 1983). Cross sections for the backwater analyses were obtained from field surveys. In some cases, USGS topographic maps (U.S. Department of the Interior, 1970, et cetera) were used to extend surveyed cross sections.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Middle Haw Creek (continued)	State Route 11	Approximately 1.5 miles upstream of confluence of Middle Haw Creek Tributary No. 2	Regionalized Regression Equations	USACE HEC-2	*	AE w/ Floodway	All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Normal depth calculations were used to set the starting water-surface elevations. Water-surface elevations for floods of the selected recurrence intervals were developed using the USACE HEC-2 water-surface profile computer model (USACE, 1974; USACE, 1976). Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen on the basis of field observations, aerial photographs of the streams and floodplain areas (State of Florida, 1978; Tetra Tech, Inc., 1981), and the USGS Water Supply Paper 1849 (USGS, 1967). The floodplain boundary was mapped by retaining the effective data and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Middle Haw Creek Tributary No. 1	Confluence with Middle Haw Creek	State Route 11	Regionalized Regression Equations	USACE HEC-2	*	AE w/ Floodway	Regionalized regression equations developed by the USGS in cooperation with the Florida Department of Transportation were used for deriving peak discharge-frequency relationships. Master drainage plans for the Palm Coast development were obtained from the ITT Corporation (Sverdrup & Parcel and Associates, Inc., Project 5089, 1977; Sverdrup & Parcel and Associates, Inc., Project 5089A). Drainage calculations on the Smoketalk Ridge Subdivision in south Flagler County were obtained from the County Engineer's office (Zahn and Gliger Engineering, Inc., 1982).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Middle Haw Creek Tributary No. 1 (continued)	Confluence with Middle Haw Creek	State Route 11	Regionalized Regression Equations	USACE HEC-2	*	AE w/ Floodway	The hydrologic calculations for the study area are detailed in Tetra Tech WRE Note 83-5 (Tetra Tech, Inc., 1983). Cross sections for the backwater analyses were obtained from field surveys. In some cases, USGS topographic maps (U.S. Department of the Interior, 1970, et cetera) were used to extend surveyed cross sections. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Normal depth calculations were used to set the starting water-surface elevations. Water-surface elevations for floods of the selected recurrence intervals were developed using the USACE HEC-2 water-surface profile computer model (USACE, 1974; USACE, 1976). Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen on the basis of field observations, aerial photographs of the streams and floodplain areas (State of Florida, 1978; Tetra Tech, Inc., 1981), and the USGS Water Supply Paper 1849 (USGS, 1967).
Middle Haw Creek Tributary No. 2	Confluence with Middle Haw Creek	Approximately 80 feet upstream of Hudson Road No. 2	Regionalized Regression Equations	USACE HEC-2	*	AE w/ Floodway	Regionalized regression equations developed by the USGS in cooperation with the Florida Department of Transportation were used for deriving peak discharge-frequency relationships. Master drainage plans for the Palm Coast development were obtained from the ITT Corporation (Sverdrup & Parcel and Associates, Inc., Project 5089, 1977; Sverdrup & Parcel and Associates, Inc., Project 5089A).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Middle Haw Creek Tributary No. 2 (continued)	Confluence with Middle Haw Creek	Approximately 80 feet upstream of Hudson Road No. 2	Regionalized Regression Equations	USACE HEC-2	*	AE w/ Floodway	Drainage calculations on the Smoketalk Ridge Subdivision in south Flagler County were obtained from the County Engineer's office (Zahn and Gliger Engineering, Inc., 1982). The hydrologic calculations for the study area are detailed in Tetra Tech WRE Note 83-5 (Tetra Tech, Inc., 1983). Cross sections for the backwater analyses were obtained from field surveys. In some cases, USGS topographic maps (U.S. Department of the Interior, 1970, et cetera) were used to extend surveyed cross sections. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Normal depth calculations were used to set the starting water-surface elevations. Water-surface elevations for floods of the selected recurrence intervals were developed using the USACE HEC-2 water-surface profile computer model (USACE, 1974; USACE, 1976). Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen on the basis of field observations, aerial photographs of the streams and floodplain areas (State of Florida, 1978; Tetra Tech, Inc., 1981), and the USGS Water Supply Paper 1849 (USGS, 1967).
Parker Canal	Confluence with Black Branch	Confluence with Sweetwater Branch	AdICPR 2.11 and USACE HEC-HMS 1.0	AdICPR 2.11	2001	AE	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Parker Canal (continued)	Confluence with Black Branch	Confluence with Sweetwater Branch	AdICPR 2.11 and USACE HEC-HMS 1.0	AdICPR 2.11	2001	AE	AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution. Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Parker Canal (continued)	Confluence with Black Branch	Confluence with Sweetwater Branch	AdICPR 2.11 and USACE HEC-HMS 1.0	AdICPR 2.11	2001	AE	From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in *Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida*, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Parker Canal was modeled using AdICPR version 2.11. This is a dynamic (non-steady state) model that is better suited to model the complicated flow patterns of these systems. The AdICPR model utilizes a simplified version of the momentum equation, commonly referred to as the energy equation, to compute discharges and water-surface elevations. Input parameters include downstream starting water-surface elevations, discharges, channel cross sections, structure dimensions, and roughness factors (Manning's "n"). Channel roughness factors (Manning's "n") used in the hydraulic computations were determined by engineering judgement shaped by field observations, aerial photographs, and published text with photographs and recommended roughness values.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Parker Canal (continued)	Confluence with Black Branch	Confluence with Sweetwater Branch	AdICPR 2.11 and USACE HEC-HMS 1.0	AdICPR 2.11	2001	AE	The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004) from confluence with Black Branch to approximately 1,240 feet upstream of State Highway 11. From approximately 1,240 feet upstream of State Highway 11 to Unnamed Road the effective mapping was retained and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Parkview Waterway	Palm Coast Parkway	Pine Lakes Parkway North	*	*	*	A	*
Pellicer Creek	Confluence with Matanzas River	Approximately 1.4 miles upstream of confluence of Hulett Branch	ADCIRC+ SWAN	JPM-OS	2015	AE	Offshore starting wave conditions are required for 1-D transect-based wave hazard analysis. As part of the JPM-OS ADCIRC+SWAN regional hydrodynamic and wave modeling significant wave heights and peak wave periods were produced at each node contained in the ADCIRC mesh. These results provided valuable information on the wave conditions that can be expected to occur during the types of extreme storm events that would produce storm surge elevations with 1- and 0.2-percent-annual-chance probabilities of occurrence. Results from the ADCIRC+SWAN modeling were used to develop starting wave conditions for the coastal hazard analyses within the study area. The Joint Probability Method with Optimal Sampling (JPM-OS) was applied to compute Stillwater Elevations (SWELs). The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004) from the confluence with Matanzas River to approximately 1.4 miles upstream of confluence of Hulett Branch.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Pellicer Creek	Approximately 1.4 miles upstream of confluence of Hulett Branch	Confluence with Pringle Branch and Stevens Branch	*	*	*	A	The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004) from approximately 1.4 miles upstream of confluence of Hulett Branch to the confluence with Pringle Branch and Stevens Branch.
Pringle Branch	Confluence with Stevens Branch and Pellicer Creek	Approximately 6.4 miles upstream of confluence with Stevens Branch and Pellicer Creek	*	*	*	A	The floodplain boundary was mapped from LiDAR data (Merrick & Co., 2004) from the confluence with Stevens Branch and Pellicer Creek to approximately 1.7 miles upstream of the confluence with Stevens Branch and Pellicer Creek. From 1.7 miles upstream of the confluence with Stevens Branch and Pellicer Creek to 6.4 miles upstream of the confluence with Stevens Branch and Pellicer Creek the effective mapping was retained and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Salt Creek	Confluence with Crescent Lake	Approximately 775 feet upstream of State Highway 100	*	*	*	A, AE	Backwater effects from Crescent Lake applied from the confluence with Crescent Lake to approximately 775 feet upstream of State Highway 100. The floodplain boundary was mapped from LiDAR data (Merrick & Co., 2004) from the confluence with Crescent Lake 100 to approximately 1.3 miles upstream of State Highway 100. From approximately 1.3 miles upstream of State Highway 100 to approximately 2.3 miles upstream of State Highway 100 the effective mapping was retained and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Sixteenmile Creek	County boundary	Approximately 1.4 miles upstream of county boundary	Regionalized Regression Equations	USACE HEC-2	*	AE w/ Floodway	Regionalized regression equations developed by the USGS in cooperation with the Florida Department of Transportation were used for deriving peak discharge-frequency relationships. Master drainage plans for the Palm Coast development were obtained from the ITT Corporation (Sverdrup & Parcel and Associates, Inc., Project 5089, 1977; Sverdrup & Parcel and Associates, Inc., Project 5089A). Drainage calculations on the Smoketalk Ridge Subdivision in south Flagler County were obtained from the County Engineer's office (Zahn and Gliger Engineering, Inc., 1982). The hydrologic calculations for the study area are detailed in Tetra Tech WRE Note 83-5 (Tetra Tech, Inc., 1983). Cross sections for the backwater analyses were obtained from field surveys. In some cases, USGS topographic maps (U.S. Department of the Interior, 1970, et cetera) were used to extend surveyed cross sections. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Normal depth calculations were used to set the starting water-surface elevations. Water-surface elevations for floods of the selected recurrence intervals were developed using the USACE HEC-2 water-surface profile computer model (USACE, 1974; USACE, 1976). Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen on the basis of field observations, aerial photographs of the streams and floodplain areas (State of Florida, 1978; Tetra Tech, Inc., 1981), and the USGS Water Supply Paper 1849 (USGS, 1967).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Stevens Branch	Confluence with Pringle Branch and Pellicer Creek	County boundary	*	*	*	A	The floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Sweetwater Branch	Confluence with Black Point Swamp	County Road 304	*	*	*	A	*
Sweetwater Branch	State Route 304	Approximately 1 mile upstream of Hudson Road No. 2	Regionalized Regression Equations	USACE HEC-2	*	AE w/ Floodway	Regionalized regression equations developed by the USGS in cooperation with the Florida Department of Transportation were used for deriving peak discharge-frequency relationships. Master drainage plans for the Palm Coast development were obtained from the ITT Corporation (Sverdrup & Parcel and Associates, Inc., Project 5089, 1977; Sverdrup & Parcel and Associates, Inc., Project 5089A). Drainage calculations on the Smoketalk Ridge Subdivision in south Flagler County were obtained from the County Engineer's office (Zahn and Gliger Engineering, Inc., 1982). The hydrologic calculations for the study area are detailed in Tetra Tech WRE Note 83-5 (Tetra Tech, Inc., 1983). Cross sections for the backwater analyses were obtained from field surveys. In some cases, USGS topographic maps (U.S. Department of the Interior, 1970, et cetera) were used to extend surveyed cross sections. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Normal depth calculations were used to set the starting water-surface elevations. Water-surface elevations for floods of the selected recurrence intervals were developed using the USACE HEC-2 water-surface profile computer model (USACE, 1974; USACE, 1976).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Sweetwater Branch (continued)	State Route 304	Approximately 1 mile upstream of Hudson Road No. 2	Regionalized Regression Equations	USACE HEC-2	*	AE w/ Floodway	Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen on the basis of field observations, aerial photographs of the streams and floodplain areas (State of Florida, 1978; Tetra Tech, Inc., 1981), and the USGS Water Supply Paper 1849 (USGS, 1967). The effective mapping was retained and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Sweetwater Branch	Approximately 1 mile upstream of Hudson Road No. 2	Approximately 1.9 miles upstream of Hudson Road No. 2	*	*	*	A	*
Tributary to Intracoastal Waterway	Confluence with Intracoastal Waterway	Approximately 1,844 feet upstream of confluence with Intracoastal Waterway	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Tributary to Intracoastal Waterway (continued)	Confluence with Intracoastal Waterway	Approximately 1,844 feet upstream of confluence with Intracoastal Waterway	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE	Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D. From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in *Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida*, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982). Channel cross sections were acquired by field survey.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Tributary to Intracoastal Waterway (continued)	Confluence with Intracoastal Waterway	Approximately 1,844 feet upstream of confluence with Intracoastal Waterway	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE	Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. Structure data were obtained from the county's Stormwater Structure Inventory plan where available (Professional Engineering Consultants, Inc., 1997). All other structure data were obtained from field surveys. The water-surface elevations are calculated from discharges estimated from the hydrologic model. Floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004).
Wadsworth/ Korona Canal	County boundary	Approximately 30 feet upstream of County Route 325	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	The hydrologic model's Advanced Interconnected Pond Routing software (AdICPR) version 2.11 and USACE's HEC-HMS (version 1.0) were applied to calculate storm flow rates. AdICPR was used to determine the runoff hydrographs for the 10-, 25-, 100-, and 500-year theoretical storm events. AdICPR was used to generate the hydrographs because it is capable of using a lower peak rate factor. The U.S. Soil Conservation Service (SCS) curve-number method described in Urban Hydrology for Small Watersheds (U.S. Soil Conservation Service, 1986) was used to determine direct runoff. A peak rate factor of 256 was used with the SCS lag equation in order to determine the runoff hydrograph. HEC-HMS was used to route the flows using the Muskingum-Cunge technique. The temporal rainfall distribution used in the models was the SCS Type II Florida modified distribution.

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Wadsworth/ Korona Canal (continued)	County boundary	Approximately 30 feet upstream of County Route 325	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	Rainfall amounts for the selected recurrence intervals were determined from Technical Paper 40 (National Weather Service, 1961). Curve numbers were calculated using digital soil and land-use coverages obtained from SJRWMD. The source data of the land-use coverages dates from 1995 and are provided in UTM, Zone 17, NAD 83 (meters) format. Land use was mapped and coded using the Anderson Classification System 91976). The source for the soils data is the USDA-NRCS SSURGO database. This data is maintained in the UTM, Zone 17, NAD 83 (meters) format. For Flagler County, all B/D and C/D soil types were assumed to have Type D soil drainage characteristics. As per the SCS TR-55 supplement (U.S. Department of Agriculture, 1969) with regards to this issue, it is stated that Type B should be used when an effective subsurface drainage system is in place; otherwise, the soil should be assumed to be Type D. From field investigation, it has been determined that storm water runoff in the developed areas is conveyed through swales. This indicates that there has been no subsurface drainage system put in place, and thus the soils should be assumed to be undrained. The modeling results were compared to the results of the regional regression equations developed for the State of Florida by the USGS, as described in *Techniques for Estimating Magnitude and Frequency of Floods on Natural Flow Streams in Florida*, Water-Resources Investigations Report 82-4012 (U.S. Department of the Interior, 1982).

Table 13: Summary of Hydrologic and Hydraulic Analysis, continued

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Wadsworth/ Korona Canal (continued)	County boundary	Approximately 30 feet upstream of County Route 325	AdICPR 2.11 and USACE HEC-HMS 1.0	USACE HEC-RAS 2.2	2001	AE w/ Floodway	Channel cross sections were acquired by field survey. Overbank cross-section data were obtained from 1:24,000 scale USGS topographic maps with 5-foot contours. Structure data were obtained from the county's Stormwater Structure Inventory plan where available (Professional Engineering Consultants, Inc., 1997). All other structure data were obtained from field surveys. The water-surface elevations are calculated from discharges estimated from the hydrologic model. From the county boundary to Interstate 95 / State Highway 9 the floodplain boundary was mapped using LiDAR data (Merrick & Co., 2004). From Interstate 95/State Highway 9 to approximately 30 feet upstream of County Route 325 the effective mapping was retained and base flood elevations and cross-section water-surface elevations were adjusted based on the countywide conversion factor of -1.037 feet.
Wadsworth/ Korona Canal	Approximately 30 feet upstream of County Route 325	Approximately 1,270 feet upstream of County Route 325	*	*	*	A	*
Winfield Waterway	Confluence with Parkview Waterway	Approximately 0.5 miles upstream of Parkview Waterway	*	*	*	A	*

*Data not available

Table 14: Roughness Coefficients

[Not Applicable to this Flood Risk Project]

5.3 Coastal Analyses

For the areas of Flagler County that are impacted by coastal flooding processes, coastal flood hazard analyses were performed to provide estimates of coastal BFEs. Coastal BFEs reflect the increase in water levels during a flood event due to extreme tides and storm surge as well as overland wave effects.

The following subsections provide summaries of how each coastal process was considered for this FIS Report. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation. Table 15 summarizes the methods and/or models used for the coastal analyses. Refer to Section 2.5.1 for descriptions of the terms used in this section.

Table 15: Summary of Coastal Analyses

Flooding Source	Study Limits From	Study Limits To	Hazard Evaluated	Model or Method Used	Date Analysis was Completed
Atlantic Ocean	Entire coastline of Flagler County	Entire coastline of Flagler County	Storm Climatology Statistical Analyses	JPM-OS	11/01/2013
Atlantic Ocean	Entire coastline of Flagler County	Entire coastline of Flagler County	Storm Surge including Regional Wave Setup	ADCIRC + SWAN	10/07/2013
Atlantic Ocean	Entire coastline of Flagler County	Entire coastline of Flagler County	Stillwater Frequency Analysis	SURGESTAT (low frequency); Regional Tidal Frequency Analysis (high frequency)	11/21/2013
Atlantic Ocean	Entire coastline of Flagler County	Entire coastline of Flagler County	Dune Erosion	FEMA's Erosion Assessment	07/07/2015
Atlantic Ocean	Entire coastline of Flagler County	Entire coastline of Flagler County	Overland Wave Propagation	WHAFIS	07/07/2015
Atlantic Ocean	Entire coastline of Flagler County	Entire coastline of Flagler County	Wave Runup	Runup 2.0, SPM, TAW	07/07/2015

5.3.1 Total Stillwater Elevations

The total stillwater elevations (stillwater including storm surge plus wave setup) for the 1% annual chance flood were determined for areas subject to coastal flooding. The models and methods that were used to determine storm surge and wave setup are listed in Table 15. The stillwater elevation that was used for each transect in coastal analyses is shown in Table 17, "Coastal Transect Parameters." Figure 8 shows the total stillwater elevations for the 1% annual chance flood that was determined for this coastal analysis.

Figure 8: 1% Annual Chance Total Stillwater Elevations for Coastal Areas

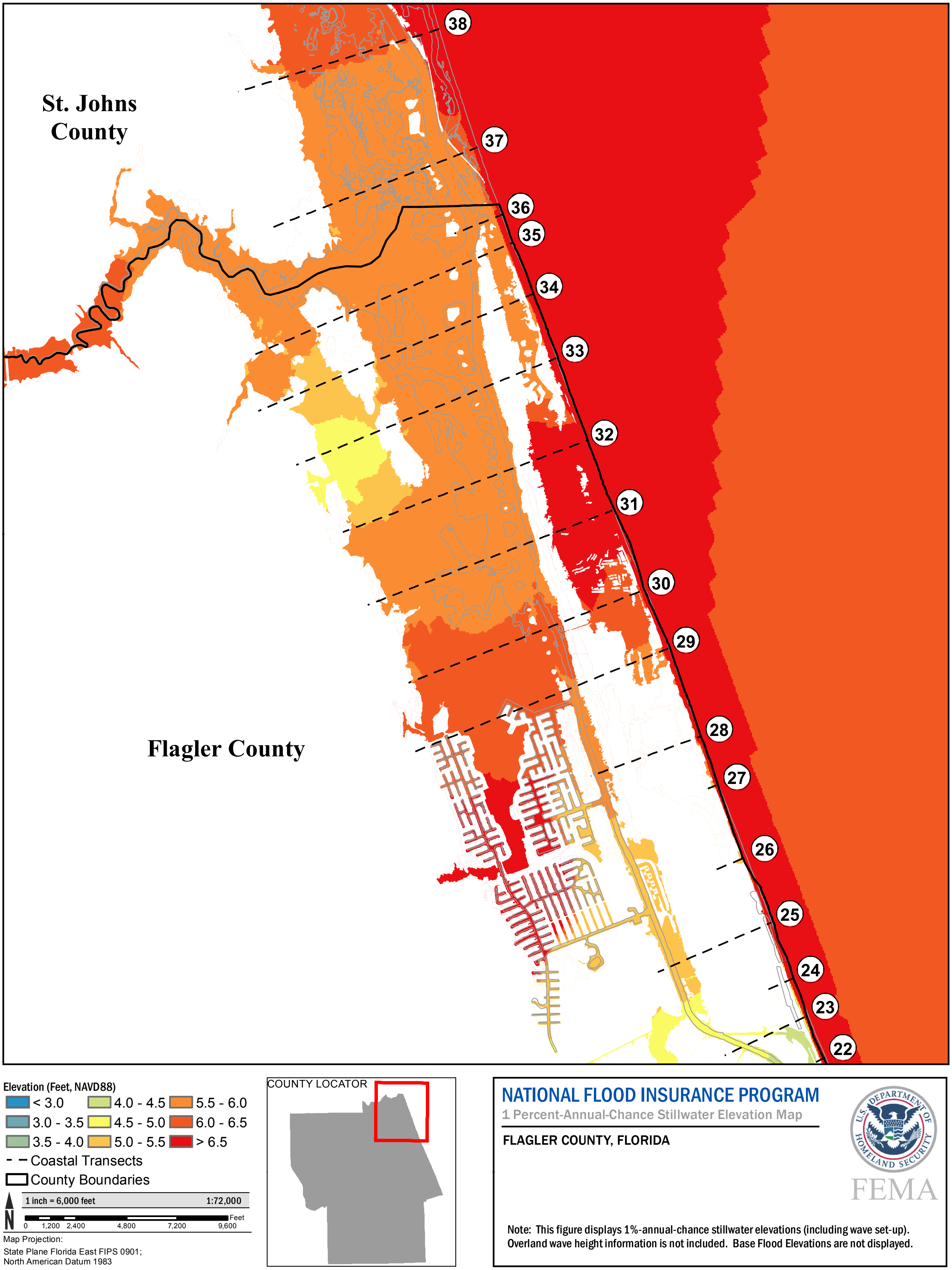
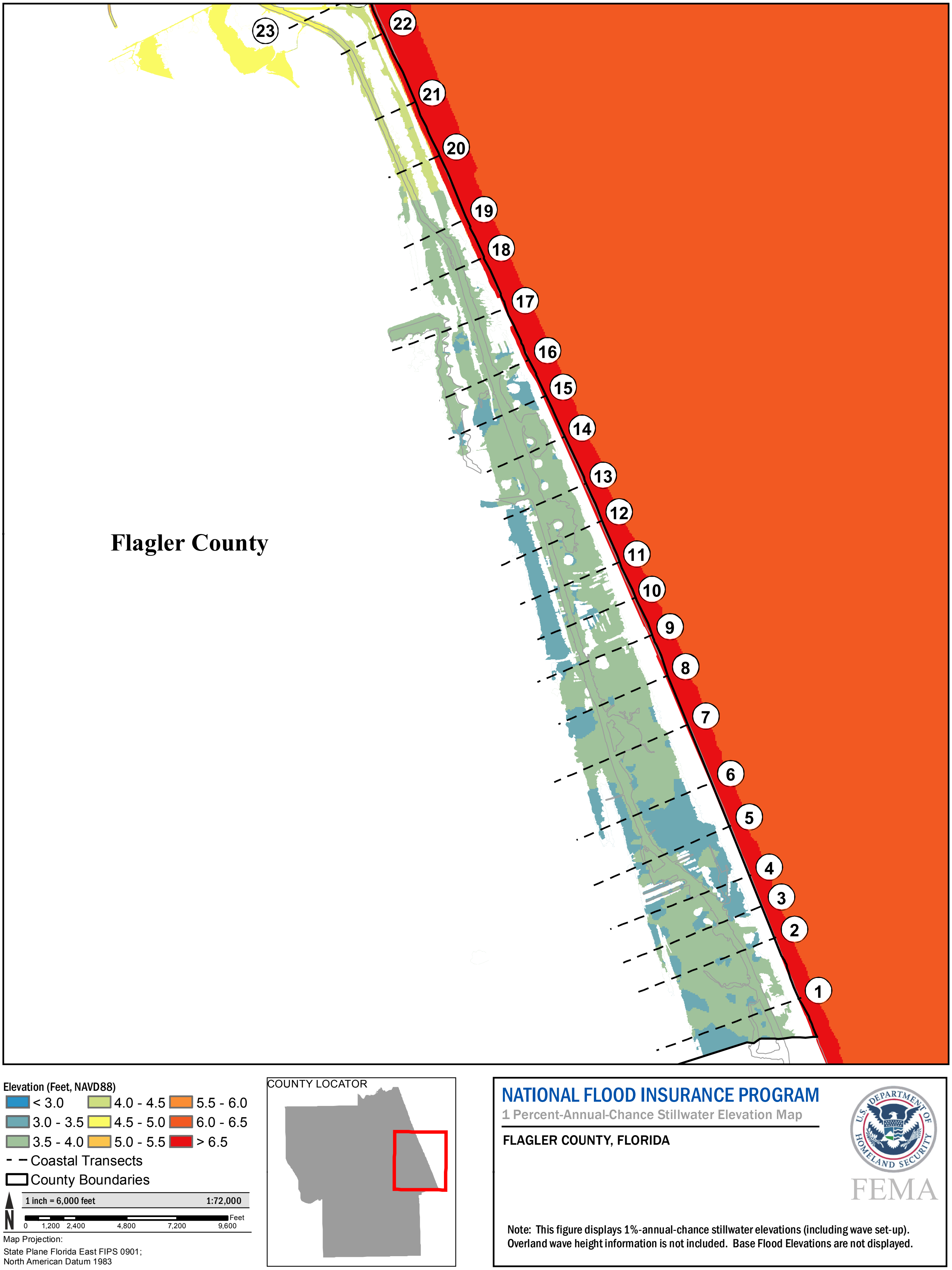


Figure 8: 1% Annual Chance Total Stillwater Elevations for Coastal Areas, continued



NATIONAL FLOOD INSURANCE PROGRAM

1 Percent-Annual-Chance Stillwater Elevation Map

FLAGLER COUNTY, FLORIDA

FEMA

Note: This figure displays 1%-annual-chance stillwater elevations (including wave set-up). Overland wave height information is not included. Base Flood Elevations are not displayed.

Astronomical Tide

Astronomical tidal statistics were generated directly from local tidal constituents by sampling the predicted tide at random times throughout the tidal epoch.

Storm Surge Statistics

Storm surge is modeled based on characteristics of actual storms responsible for significant coastal flooding. The characteristics of these storms are typically determined by statistical study of the regional historical record of storms or by statistical study of tide gage water levels.

When historic records are used to calculate storm surge, characteristics such as the strength, size, track, etc., of storms are identified by site. Storm data such as wind and pressure fields were used with hydrodynamic models to compute storm surge levels.

Statistical analyses were performed to determine the annual chance flood elevations for the GANFEL study. The study considered both high frequency (i.e., 50-, 25-, 10-, and 4-percent-annual-chance) events as well as low frequency (i.e., 2-, 1-, and 0.2-percent-annual-chance) events.

Flood estimates for the low frequency events were derived by simulating a large number of storm events using a coupling of hydrodynamic and wave models (i.e., the ADCIRC - ADvanced CIRCulation model, Luettich and Westerink (2004), and the SWAN - Simulating Waves Nearshore model, Delft University of Technology (2006)). Key storm parameters (central pressure deficit, radius to maximum winds, forward speed, track heading, and the Holland's B parameter) were used to represent a population of historic and synthetic storm events representative of the study region. The Joint Probability Method with Optimal Sampling (JPM-OS), developed by Resio (2007) and Toro et. al. (2010), was applied to compute Stillwater Elevations (SWELs), which include the storm surge component and the wave setup component.

Tidal gages can be used instead of historic records of storms when the available tidal gage record for the area represents both the astronomical tide component and the storm surge component. Table 16 provides the gage name, managing agency, gage type, gage identifier, start date, end date, and statistical methodology applied to each gage used to determine the Stillwater elevations. High frequency events were computed based on the approach described in the report "Tide Gage Analysis for the Atlantic and Gulf Open Coast" dated December 2, 2008 (Federal Emergency Management Agency, 2008). The methods from this previous study were applied to updated tide records, through the end of 2012, which added six years of additional data to the analysis. In addition, the regionalization of the tide gages from the previous study was re-evaluated and revised using the additional data and observations of revised statistical parameters.

Table 16: Tide Gage Analysis Specifics

Gage Name	Managing Agency of Tide Gage Record	Gage Type	Start Date	End Date	Statistical Methodology
Charleston – 8665530	NOAA	Tide	1899	Present	L-moments, GEV

Table 16: Tide Gage Analysis Specifics, continued

Gage Name	Managing Agency of Tide Gage Record	Gage Type	Start Date	End Date	Statistical Methodology
Fort Pulaski – 8670870	NOAA	Tide	1935	Present	L-moments, GEV
Fernandina Beach – 8720030	NOAA	Tide	1898	Present	L-moments, GEV
Mayport Ferry Depot - 8720220	NOAA	Tide	1928	2008	L-moments, GEV
St. Augustine – 8720587	NOAA	Tide	1992	2004	L-moments, GEV
Daytona Beach Shores – 8721120	NOAA	Tide	1966	1984	L-moments, GEV
Trident Pier – 8721604	NOAA	Tide	1994	Present	L-moments, GEV
Lake Worth Pier – 8722670	NOAA	Tide	1970	Present	L-moments, GEV
Miami Beach – 8723170	NOAA	Tide	1931	1981	L-moments, GEV
Virginia Key - 8713214	NOAA	Tide	1994	Present	L-moments, GEV

Combined Riverine and Tidal Effects

A combined probability analysis was conducted to compute a 1-percent-annual-chance BFE for areas subject to flooding by both coastal and riverine flooding mechanisms. Since riverine and coastal analyses were based on independent events, the resulting combined BFE would be higher than that of their individual occurrence. In other words, at the location where the computed 1-percent-annual-chance coastal flood level equals the computed 1-percent-annual-chance riverine flood level, there was a greater than 1-percent-annual-chance of this flood level being equaled or exceeded. In Flagler County, combined probability calculations were performed for Big Mulberry Branch, Bulow Creek, and Graham Swamp.

Wave Setup Analysis

Wave setup was computed during the storm surge modeling through the methods and models listed in Table 15 and included in the frequency analysis for the determination of the total stillwater elevations.

5.3.2 Waves

Offshore wave conditions were modeled as part of the regional hydrodynamic and wave modeling (i.e., ADCIRC + SWAN). The regional model results provided valuable information on the wave conditions that could be expected to occur during the types of extreme storm events that would produce storm surge elevations with 1- and 0.2-percent-annual-chance probabilities of occurrence. Wave heights and periods derived from the SWAN model results were used as inputs to the wave hazard analyses described in Section 5.4.3.

5.3.3 Coastal Erosion

A single storm episode can cause extensive erosion in coastal areas. Storm-induced erosion was evaluated to determine the modification to existing topography that is expected to be associated with flooding events. Erosion was evaluated using the methods listed in Table 15. The post-event eroded profile was used for the subsequent wave hazard analyses.

5.3.4 Wave Hazard Analyses

Overland wave hazards were evaluated to determine the combined effects of ground elevation, vegetation, and physical features on overland wave propagation and wave runup. These analyses were performed at representative transects along all shorelines for which waves were expected to be present during the floods of the selected recurrence intervals. The results of these analyses were used to determine elevations for the 1% annual chance flood.

Transect locations were chosen with consideration given to the physical land characteristics as well as development type and density so that they would closely represent conditions in their locality. Additional consideration was given to changes in the total stillwater elevation. Transects were spaced close together in areas of complex topography and dense development or where total stillwater elevations varied. In areas having more uniform characteristics, transects were spaced at larger intervals. Transects shown in Figure 9, "Transect Location Map," are also depicted on the FIRM. Table 17 provides the location, stillwater elevations, and starting wave conditions for each transect evaluated for overland wave hazards. In this table, "starting" indicates the parameter value at the beginning of the transect.

Wave Height Analysis

Wave height analyses were performed to determine wave heights and corresponding wave crest elevations for the areas inundated by coastal flooding and subject to overland wave propagation hazards. Refer to Figure 6 for a schematic of a coastal transect evaluated for overland wave propagation hazards.

Wave heights and wave crest elevations were modeled using the methods and models listed in Table 15, "Summary of Coastal Analyses". For the 0.2-percent-annual-chance event, wave profiles were created to indicate the results of the wave height analysis at each transect (FEMA, 2007). Such wave profiles may show greater detail than the mapping product, due to limitations of the map scale and smoothing tolerances applied during boundary cleanup . Wave runup analysis for the 0.2-percent-annual-chance event was not performed for this study and is not included in the profiles.

Wave Runup Analysis

Wave runup analyses were performed to determine the height and extent of runup beyond the limit of stillwater inundation for the 1% annual chance flood. Wave runup elevations were modeled using the methods and models listed in Table 15.

Table 17: Coastal Transect Parameters

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Atlantic Ocean	1	18.64	13.62	2.2 1.6 - 2.2	2.3 1.8 - 2.3	2.9 2.1 - 2.9	6.9 3.3 - 6.9	9.4 4.9 - 9.4
Atlantic Ocean	2	18.73	13.50	2.2 0.5 - 2.2	2.3 1.7 - 2.3	2.9 2.1 - 2.9	7.0 3.2 - 7.0	9.5 4.9 - 9.5
Atlantic Ocean	3	18.63	13.65	2.2 0.5 - 2.2	2.3 1.7 - 2.3	2.9 2.1 - 2.9	7.0 3.2 - 7.2	9.4 4.9 - 9.6
Atlantic Ocean	4	18.65	13.37	4.3 0.8 - 4.3	4.7 1.7 - 4.7	5.8 2.1 - 5.8	7.0 3.2 - 7.0	9.5 4.9 - 9.5
Atlantic Ocean	5	18.69	13.26	3.9 1.7 - 3.9	4.2 1.8 - 4.2	5.7 2.1 - 5.7	7.1 3.3 - 7.1	9.6 5.0 - 9.8
Atlantic Ocean	6	18.45	13.46	4.0 1.6 - 4.0	4.3 1.7 - 4.3	5.5 2.1 - 5.5	6.9 3.2 - 7.1	9.4 4.9 - 9.7
Atlantic Ocean	7	18.78	13.42	4.4 0.0 - 4.4	4.7 1.5 - 4.7	5.9 1.9 - 5.9	7.0 3.2 - 7.0	9.5 4.9 - 9.5

Table 17: Coastal Transect Parameters, continued

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Atlantic Ocean	8	19.04	13.29	4.8 1.7 - 4.8	5.1 1.8 - 5.1	6.3 2.3 - 6.3	7.1 3.4 - 7.3	9.6 5.0 - 9.8
Atlantic Ocean	9	18.72	13.38	4.6 1.4 - 4.6	4.9 1.5 - 4.9	6.1 1.9 - 6.1	7.1 3.1 - 7.2	9.8 4.7 - 9.8
Atlantic Ocean	10	18.65	13.39	4.5 0.1 - 4.5	4.8 1.5 - 4.8	6.0 1.9 - 6.0	7.1 3.1 - 7.1	9.6 4.7 - 9.6
Atlantic Ocean	11	18.93	13.38	4.3 1.5 - 4.3	4.6 1.6 - 4.6	5.7 2.0 - 5.7	7.1 3.1 - 7.1	9.6 4.8 - 9.6
Atlantic Ocean	12	18.93	13.33	4.5 1.5 - 4.5	4.8 1.6 - 4.8	5.9 2.0 - 5.9	7.1 3.2 - 7.1	9.6 4.8 - 9.6
Atlantic Ocean	13	18.66	13.25	4.5 1.2 - 4.5	4.8 1.6 - 4.8	5.9 2.0 - 5.9	7.1 3.29 - 7.1	9.6 4.9 - 9.6
Atlantic Ocean	14	18.72	13.07	4.7 2.1 - 4.7	5.1 2.3 - 5.1	6.3 2.8 - 6.3	7.2 3.6 - 7.3	9.8 5.1 - 9.8

Table 17: Coastal Transect Parameters, continued

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Atlantic Ocean	15	18.68	13.01	4.5 0.7 - 4.5	4.8 1.7 - 4.8	5.9 2.1 - 5.9	7.1 3.3 - 7.1	9.6 5.0 - 9.6
Atlantic Ocean	16	18.79	13.00	4.6 0.0 - 4.6	4.9 2.4 - 4.9	6.1 3.0 - 6.1	7.2 3.8 - 7.2	9.7 5.1 - 9.7
Atlantic Ocean	17	18.59	13.11	4.6 1.9 - 4.6	4.9 2.1 - 4.9	6.1 2.9 - 6.1	7.2 3.5 - 7.2	9.6 5.1 - 9.7
Atlantic Ocean	18	18.58	12.87	4.6 1.3 - 4.6	4.9 2.2 - 4.9	6.1 2.6 - 6.1	7.2 3.6 - 7.2	9.7 5.2 - 9.7
Atlantic Ocean	19	18.93	12.84	4.7 2.4 - 4.7	5.0 2.5 - 5.0	6.2 3.1 - 6.2	7.2 3.8 - 7.2	9.7 5.2 - 9.7
Atlantic Ocean	20	18.85	13.04	4.7 2.6 - 4.7	5.0 2.8 - 5.0	6.2 3.3 - 6.2	7.3 4.1 - 7.3	9.8 5.4 - 9.8
Atlantic Ocean	21	18.75	13.04	4.7 2.4 - 4.7	5.1 2.6 - 5.1	6.3 3.2 - 6.3	7.3 4.1 - 7.3	9.8 5.6 - 9.8

Table 17: Coastal Transect Parameters, continued

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Atlantic Ocean	22	18.74	13.00	4.8 1.1 - 4.8	5.1 2.7 - 5.1	6.3 3.3 - 6.3	7.3 4.2 - 7.3	9.8 5.9 - 9.8
Atlantic Ocean	23	18.59	12.99	4.6 2.7 - 4.6	4.9 2.9 - 4.9	6.1 3.6 - 6.1	7.2 4.5 - 7.2	9.7 6.1 - 9.7
Atlantic Ocean	24	18.22	12.99	4.6 3.5 - 4.6	4.9 3.8 - 4.9	6.1 4.5 - 6.1	7.1 4.5 - 7.1	9.6 6.1 - 9.6
Atlantic Ocean	25	18.67	12.71	4.6 3.2 - 4.6	4.9 3.5 - 4.9	6.1 4.3 - 6.1	7.2 5.1 - 7.2	9.6 6.9 - 9.6
Atlantic Ocean	26	18.40	12.73	4.6 2.0 - 4.6	4.9 3.4 - 4.9	6.1 4.2 - 6.1	7.2 5.2 - 7.2	9.6 7.3 - 9.6
Atlantic Ocean	27	18.49	12.96	4.6 3.7 - 4.6	5.0 4.0 - 5.0	6.1 4.9 - 6.1	7.2 5.3 - 7.2	9.6 7.4 - 9.6
Atlantic Ocean	28	18.67	12.98	4.6 3.5 - 4.6	5.0 3.8 - 5.0	6.1 4.6 - 6.1	7.2 5.7 - 7.2	9.6 7.8 - 9.6

Table 17: Coastal Transect Parameters, continued

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Atlantic Ocean	29	18.97	12.94	4.7 0.8 - 4.7	5.0 4.0 - 5.0	6.2 4.8 - 6.2	7.3 6.0 - 7.3	9.7 8.4 - 9.7
Atlantic Ocean	30	18.45	12.90	4.7 3.6 - 4.7	5.0 3.9 - 5.0	6.2 4.3 - 6.2	7.3 5.9 - 7.3	9.6 8.4 - 9.6
Atlantic Ocean	31	19.09	13.02	4.6 1.1 - 4.6	5.0 3.9 - 5.0	6.1 4.0 - 6.1	7.2 5.6 - 7.3	9.7 8.2 - 9.7
Atlantic Ocean	32	18.56	13.12	4.7 0.0 - 4.7	5.0 3.0 - 5.0	6.2 3.6 - 6.2	7.4 5.2 - 7.4	9.8 8.0 - 9.8
Atlantic Ocean	33	18.62	13.20	4.8 0.8 - 4.8	5.1 2.4 - 5.1	6.3 3.0 - 6.3	7.4 5.0 - 7.4	9.8 7.9 - 9.8
Atlantic Ocean	34	18.55	13.21	4.7 0.3 - 4.7	5.0 2.5 - 5.0	6.2 3.1 - 6.2	7.3 5.1 - 7.4	9.7 7.9 - 9.7
Atlantic Ocean	35	18.65	13.23	4.9 0.0 - 4.9	5.2 3.5 - 5.2	6.5 4.0 - 6.5	7.5 5.4 - 7.5	9.8 7.9 - 9.8

Table 17: Coastal Transect Parameters, continued

Flood Source	Coastal Transect	Starting Wave Conditions for the 1% Annual Chance		Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)				
		Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Atlantic Ocean	36	18.65	13.23	4.7 0.4 - 4.7	5.0 3.4 - 5.0	6.1 4.1 - 6.1	7.4 5.7 - 7.4	9.8 8.0 - 9.8
Atlantic Ocean	37*	18.74	13.36	4.7 3.5 - 4.7	5.1 3.7 - 5.1	6.3 4.17 - 6.3	6.9 5.6 - 7.1	9.2 7.9 - 9.4
Atlantic Ocean	38*	18.84	13.57	4.9 3.4 – 5.0	5.3 3.7 - 5.3	6.5 4.5 - 6.6	7.7 6.0 - 7.8	9.8 8.3 - 10.2

*Transect originates in St. Johns County, Florida. See St. Johns County FIS Report. Detailed analyses for these transects are to be found in the St. Johns County, Florida, Technical Support Data Notebook (TSDN).